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THE BATTLE OF VELESTINO—THE GREEKS BRINGING IN THEIR WOUNDED FROM THE FIGHTING LINE.

THE BATTLE OF VELESTINO.

Our front page engraving shows one of the tragic episodes of the Greco-Turkish war. The special artist and the war correspondent are now beginning to present truthful pen and pencil pictures of this short and decisive war, which has been so interesting from a military point of view.

Among the most important encounters between the Greek and the Turkish armies were those at Pharsalos and Velestino. On May 5, the Greek line was attacked by a strong Turkish force of 20,000 infantry, in addition to large forces of artillery and cavalry. Both the Greek wings repulsed the Turks with great slaughter. The railroad station was destroyed by Turkish soldiers and railway communication between Pharsalos and Volo was interrupted.

On May 6, many wounded Turkish soldiers struggled into Larissa, confirming the report of the capture of Velestino by the Turks, where the fighting was very severe. The engagement between the Turks and Greeks lasted for several hours, and the conflict ended in the defeat of the Greeks, their forces retreating in the direction of Volo and also on Almyros, the Turks pursuing. Later a Turkish division succeeded in forcing its way to the fourth and last line of the Greek entrenchment on the heights in the rear of Velestino. The fight was of short duration; both sides fought with great courage and determination, but the fire of the Turkish infantry eventually decided the result. Toward the end of the action the Turkish artillery fire was directed with the greatest accuracy. The shrapnel fire upon this occasion and in the previous engagements before Pharsalos was murderous, almost every shell being accurately pitched. The Turkish loss at Pharsalos was slight, since only the advance guard of the Turks was engaged, and the skirmishers had the way cleared for them by the fire of the Turkish batteries. The Turkish loss in the fighting at Velestino was heavier. Two hospitals at Larissa were almost filled with the wounded.

After these engagements there was nothing to prevent the Turkish troops from entering Volo, which they did on May 8. The special correspondent of the Illustrated London News, Mr. H. C. Seppings Wright, says: "The wounded, with their blistering gashes and blackened bullet wounds, were brought in, some on donkeys, others on horseback surrounded and supported by a tired, good-hearted band of soldier helpers. The trolley was used for the worse cases, being pushed along the heavily laden line. Some were carried on stretchers, the distance from the battlefield to the train being considerable, since, on account of the shell fire of the Turks, the train was halted about two miles off at the distance to the pass to Volo." For our engraving we are indebted to L'Illustration.

SUBMARINE TELEGRAPHY DURING WAR.

Below we give a digest of a paper read by Lieutenant Crutchley, R.N.R., on "Rapid Cable Laying for War Purposes," before the Royal United Service Institution. As the purport of the paper is one well worth the consideration of all who are interested in the success of any future naval operations the British nation may be called upon to carry out should it unhappily be engaged in war, we are glad to be able to give a digest of it, and an illustrated description of the mechanical methods employed by their inventor, Mr. C. Scott Snell, in putting overboard a submarine cable at a high rate of delivery. It goes without comment that in all future naval warfare the earliest possible intelligence of the occurrences attending it will be invaluable, not only to those directing its operations, but to all for whose benefit and safety it is being waged. The mere contact of Great Britain with the rest of the world, by steamship only, would now be unbearable, and the loss of communication by overland and submarine telegraphy is not to be thought of in its effects upon our welfare as a nation. That the latter kind of communication will play a most important part in any future naval war cannot be doubted, and the purport of reading the paper before referred to was to elicit an opinion as to whether it would not be advantageous to a naval commander in chief to have the means at his disposal of communicating with his base, or a picket of ships at from 300 to 500 miles distance, by a cable payed overboard at fast cruiser speed, or, say, twenty knots an hour. Although this speed would be far in excess of anything hitherto attained in cable laying, the inventor of the apparatus we here illustrate claims that he can safely and successfully effect it.

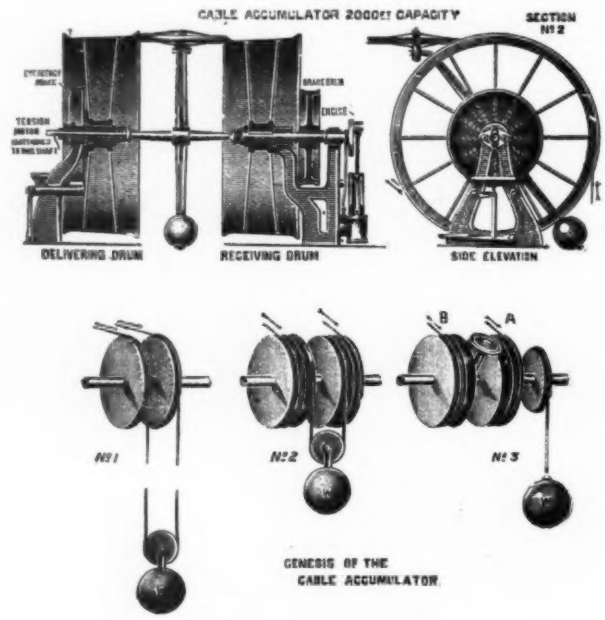
To appreciate his proposals, however, the mind must altogether be disabused of the notion that the cable is to be laid in the ordinary way, viz., by being dragged out of the ship, as in such case its length when laid at a high speed could not exceed the distance traversed by the vessel, and no provision would thereby be made for such an excess of delivery as would be necessary to compensate for inequalities of sea bottom, etc., as it is evident that at 20 knots the angle assumed by the cable would be very small, possibly less than five degrees; and it is these extra contingencies, such as the risk of not allowing sufficient "slack" in paying out, and causing an outside stress to come upon the cable, that have to be provided for. For ordinary power transmission purposes by steel cables a speed of 80 ft. per second, or about double the rate required for such high speed cable laying as proposed, is not uncommon; so that there is nothing to prevent appliances being used to rapidly transmit a quantity of cable from one position to another some hundreds of feet away, or from the hold of a vessel into the sea astern.

To prevent such a strain as that caused by want of "slack" in paying out coming upon a cable, the inventor of the gear under notice makes the following provision: In the stern of the vessel—see Fig. 1—is fitted a pulley driven by a motor of comparatively small power, which "ejects" the cable overboard; forward of this pulley is a "cable accumulator," consisting of a receiving and delivering drum, each capable of holding 1,000 ft. of cable, which is fed on to them—in the single drum system shown in Fig. 1 as applied on a naval cruiser—from a main cable drum, which has a capacity for 300 knots, located within a suitable tank, as shown under the protective deck. The cable would be a conductor made up of seven tinned copper wires insulated with pure and vulcanized India rubber, sheathed with steel wires, and having an over-all diameter of 0·45 in., its weight being in air, when dry, 11·4 cwt., or 8·75 cwt. when immersed in sea water, per knot of length.

The modus operandi of laying a cable with this arrangement is as follows: The main or 300 knot drum being fully loaded with cable is rotated by independent engines sufficiently powerful to give a paying out speed of 20 knots an hour, from a state of rest, in about 1½ minutes. Fully loaded, the drum would have to revolve about forty-five times in a minute, this speed being gradually increased to about 100 revolutions as the drum is depleted of its load of cable to keep up the same rate of delivery. From the main drum the cable passes to the accumulator, on which is maintained 2,000 ft. under a constant tension, and from thence to the stern pulley, and until the bight of the cable between this pulley and the main supply is all paid out no abnormal stress can be set up on the remainder of the cable.

The way in which this is effected by the accumulator will be more easily understood by the following explanation of its genesis, which is an abridgment of that given by the inventor in the paper. In principle it consists, as shown in diagram No. 1, Fig. 2, of a pair of sheaves over which the cable is laid, a bight of 2,000 ft. being supposed to hang down, to which a constant tension is applied by a weight upon a third sheave. On board ship a vertical traverse of 1,000 ft. would, of course, be impossible, but if two upper sheaves of considerable width are placed side by side, as shown in diagram No. 2, each sheave constitutes a drum capable of holding 1,000 ft. of cable, and by imagining the drums to be filled, the weight will have been raised till its sheave touches them. If now the weight be dispensed with, and the sheave be attached to an arm radiating from the axle between the two drums, as in diagram No. 3, the sheave will be free to revolve in a plane tangential to the circumference of the two drums, and it has at the same time a clear orbit around them.

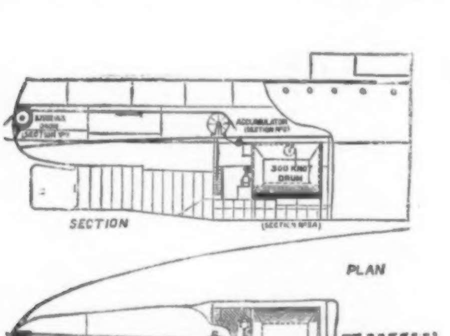
Assuming the system to have become as shown in diagram No. 3—the drums being loose on the axle—and that the weight, W, represents the effect of a small retarding motor, it will be seen that if the rate of supply of cable at A is, say, 20 ft. per second, while the demand at B is 21 ft., the tangential sheave will be carried round against the torsion of its motor, and a steady retarding stress be maintained on the cable. Both drums will be practically empty in 2,000 seconds, as each complete revolution of the arm will take one turn off each drum. The arm with its accessories will rotate at two revolutions per minute, while the two drums and the sheave will be rapidly revolving on their separate axes, independent of other motion.

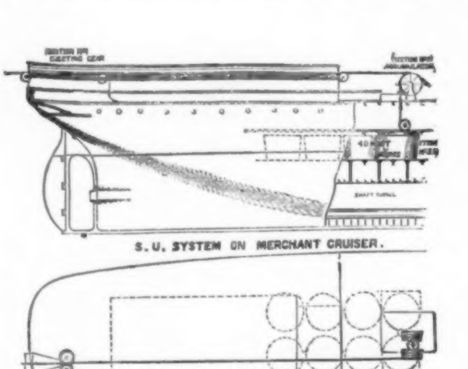


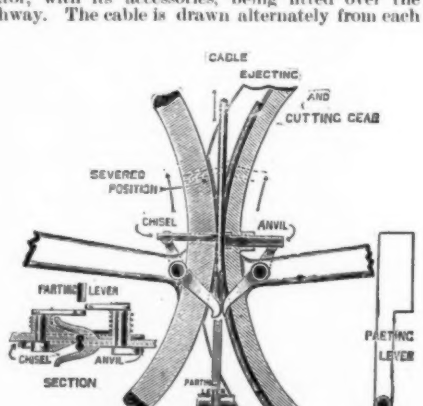
From the genesis of the "cable accumulator" shown in diagrams 1, 2, 3, in Fig. 2, it has resolved itself into the arrangement shown in the upper part of the same figure, which needs little explanation, the two drums being shown mounted loosely on an axle to which is centrally attached the counterbalanced radiating arm carrying the tangential sheave, which receives and delivers the cable from one drum to the other, together with the tension and retarding motors. In this—the single main drum system—the rate of delivery of the cable overboard is governed by the speed given to the stern pulley. Should stress outside the ship occur, however, due to insufficient paying out speed, this pulley acquires an increased rate of revolution, but no injury occurs to the cable by reason of the induced flexibility caused by the accumulator coming into action.

In the case of merchant cruisers, the system adopted in rapid cable laying would be that shown in Fig. 3, where a series of drums of forty knot capacity are arranged in tiers in the afterhold of the vessel, the accumulator, with its accessories, being fitted over the hatchway. The cable is drawn alternately from each tier, the wire being suitably joined up. When a drum becomes depleted, the continuation of the cable leads to the adjacent drum.

As the cutting of a cable paid out at a very rapid rate has certain attendant difficulties and risks, unless effected quite astern of all deck gear, and in a way not to necessitate a sudden stoppage of the paying out gear while under stress, its severance is proposed to be effected by the gear shown in Fig. 4. It being assumed that the cable has two or more turns round the ejector drum astern, it is pressed upon before leaving it by a wheel of the same diameter, means being taken to insure the synchronism of the movements of both. In the periphery of one wheel is fitted a chisel, and in that of the other an anvil; to these are fitted tail levers moving in different planes—as shown in the section in





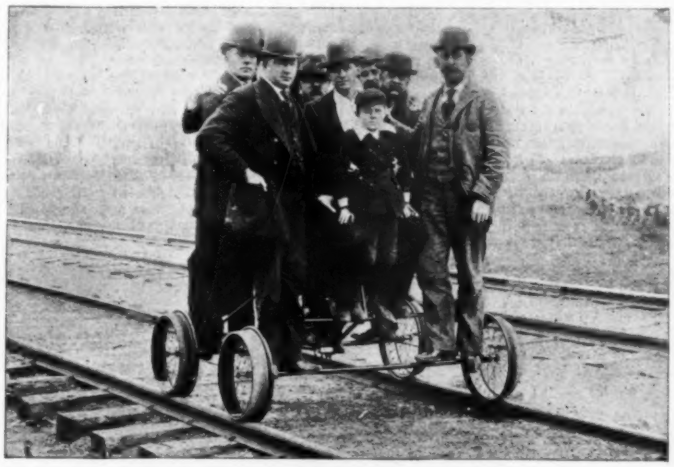


the figure—which on a parting lever being dropped between them are forced outward, causing the chisel and anvil to protrude as the wheels turn, and thus sever the cable. As severance takes place means are provided for removing the parting lever at once, as otherwise the cable would be cut up into short lengths.

For the illustrations given in this article we are indebted to the courtesy of the Council of the Royal United Service Institution.—Engineer.

A SIXTY POUND RAILWAY INSPECTION CAR.

IN the SCIENTIFIC AMERICAN of April 24 there appeared an article which described and illustrated the most powerful locomotives in the world. In startling contrast with those massive engines is the delicate machine of the accompanying illustration, the Hartley and Teeter railway cycle or light inspection car, built by the Railway Cycle Manufacturing Company of Hagerstown, Ind. It is of 4 ft. 8½ in. gage and weighs 60 lb. In its construction only such material is used as has great strength in connection with light weight. The frame is made of cold drawn steel tubing so disposed as to form a true truss, and is braced with spring steel, transversely, diagonally, and longitudinally. Any weight applied to the frame is distributed evenly to all of the axle bearings. These bearings are of the ball pattern throughout, and consist of but two parts, the cone and cup. By the adoption of an ingenious plan of construction, the axles do not form any part of the frame. Strong steel tubes form the transverse sections of the frame, and into these tubes the axles are inserted. By reason of this device the axle bearings will not bind under any kind of weight, and all side strain will be applied against the bearing cases. The wheels consist of steel hub and rim with tangent spokes, and fitted with non-slippable rubber tires. The car is propelled by foot pedals, turning a sprocket over which runs a chain to sprocket on rear axle. It has adjustable handle bars, not used for steering, and has saddle of the latest bicycle pattern.



A SIXTY POUND RAILWAY INSPECTION CAR.

The great strength of this car was demonstrated recently in a very practical way. A number of persons whose weight was 1,667 lb. were mounted upon one of the regularly built single seated cars, the weight of which was 60 lb. While bearing this load, the car was operated over the track by one person, at the rate of 5 miles an hour, in both forward and backward directions. The bearings did not bind, neither was the frame strained or damaged in the least.

The car is intended to carry one person and 100 to 125 lb. of baggage or tools, and this test does not furnish a precedent to be followed, any more than the car axle test furnishes the amount of its carrying capacity. A car load of these cars has recently been shipped to Moscow, Russia.

THE LUCIPHORE—FOR DISTRIBUTING IGNITED MATCHES.

THE luciphore is a small apparatus designed to permit of getting all the good possible out of poor or indifferent matches, which, when struck, ignite or do not ignite, as the case may be, and which are apt to go out suddenly even if they do ignite, or to lose their heads when the matches are scratched.

The apparatus consists of a nickel plated block of metal resembling a paper weight, and capable, in fact, of being used as such. It is 3½ in. in length, 2½ in width, and 2¾ in height, and somewhat resembles a roller top desk on a very small scale. After the lateral door shown in Fig. 1 has been opened, a supply of matches is introduced into the receptacle in the interior. This bundle of matches tends to descend to the lower part, where there is a transverse groove. One of the matches enters this and lies therein horizontally (see cartouche in Fig. 2). In front there is a key. As soon as this is pressed with a quick motion, the match rubs against a small steel comb arranged at the extremity of the groove, but which is not visible in the figure. The match, which is held at the opposite end by a spring, rises quickly at the same moment and becomes vertical. This new position is shown in the general view of the apparatus (Fig. 1). The key has been depressed, and the match that has come from the interior has ignited and is quietly burning.

The maneuver is very simple. Depress the key, and the match will ignite and rise abruptly after the fashion of a jack-in-a-box. Then, standing as straight as a wax taper, it will slowly burn to the great satisfaction of the consumer.

All the matches of the entire supply are thus utilized, one after the other, and each one falls into the groove and is ignited under the eye of the operator. If a slight resistance is felt when the key is pressed, it is because the match has not adapted itself properly to the horizontal groove. In order to get things working properly again, it will suffice to maneuver the key somewhat delicately; then, after a quick motion of the key, the match will become ignited. A failure to strike fire with this apparatus does not often occur. It is even possible to judge of the quality of a box of matches by the way in which the latter ignite in the luciphore.

In an ordinary sulphur match, the phosphorus composition first ignites, then the sulphur catches fire, and finally the wood burns with a perfectly vertical flame.

This little apparatus is very ingenious. It constitutes a very cheap automatic lighter as well as a distributer of ignited matches, and will permit of effecting a saving in matches along with a saving in patience! Just think of matches that ignite at the first scratch! Such a thing seems scarcely credible!—La Nature.

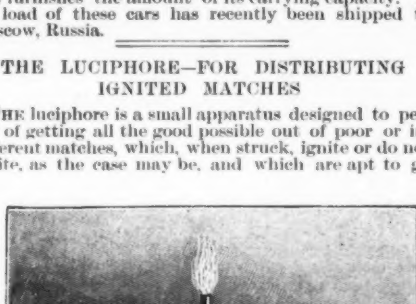


FIG. 1.—THE LUCIPHORE.

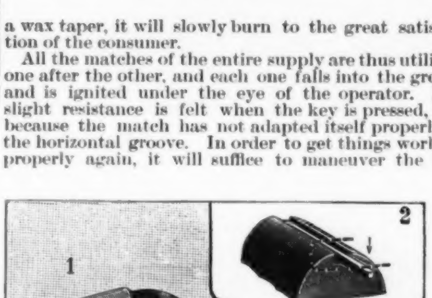


FIG. 2.—VIEW OF THE INTERIOR.

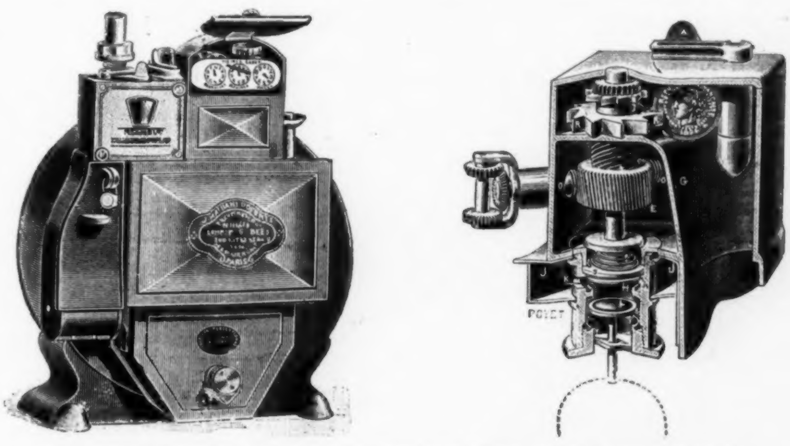
A COIN-IN-THE-SLOT GAS METER.

THE object of coin-in-the-slot gas meters is to facilitate the use of gas by the laboring class, either for lighting or cooking. They permit of the introduction of the current of gas into the meter, and consequently its subsequent distribution, only in measure as it is paid for by tenths of a dollar. This method of payment has the advantage of proportioning the quantity of gas used every day to the resources of every household and of preventing the presentation of large bills at the end of the month.

The meter represented in the accompanying figures operates as follows: After the introduction of each coin, which, in falling, interposes itself between two of the ten teeth of a ratchet wheel, a handle is turned in the proper direction. In this motion the coin causes the ratchet wheel to make a tenth of a revolution, and causes a screw to which is fixed a clack valve to rise to a certain height. This clack, when lifted, allows the gas to enter the meter; but since through a series of gear wheels actuated by the vertical shaft of the meter, the screw that maneuvers the clack descends (for a discharge of ten cents' worth of gas) to the same extent that it rose, it results that the passage of the gas is interrupted after a volume corresponding to ten cents' worth has been consumed.

It is then necessary to put another coin into the meter in order to obtain a new flow of gas.

The movement of a sector, colored black and maneuvered by a special tappet, in front of an aperture upon which are inscribed ten divisions corresponding to ten coins, permits of knowing at any instant the quantity of gas paid for in advance. After all the gas paid for has been used, the sector completely covers the aperture.—L'Illustration.



COIN-IN-THE-SLOT GAS METER—PERSPECTIVE VIEW AND SECTION.

PUMPING ENGINES FOR ROTTERDAM.

IN 1869 the municipality of Rotterdam decided to build waterworks for supplying the city with filtered water from the river Meuse. These works, calculated on a basis of a daily consumption of 5,000 cubic meters (1,100,000 gallons), were completed in 1874.

The pumping plant consisted of two horizontal single cylinder engines, each driving two pumps placed tandem and worked direct off the piston rod, the pump next to the steam cylinder forcing the water into the city main, the head being 30 meters (98 ft. 5 in.); and the second pump delivering the water from the river on to the filters, a lift of only 3 meters to 5 meters (10 ft. to 17 ft.) The latter pump does not draw from the river directly, but from large depositing reservoirs, the water for a day's consumption being only taken from the river during a few hours after the beginning of the ebb tide.

The water consumption of the city increased rapidly, and the first pair of pumping engines, delivering 500 cubic meters (110,000 gallons) per hour each, soon proved insufficient, especially on hot summer days, the water consumption being then greatly in excess of the mean daily consumption during a month.

In 1879 two engines of the same construction, but delivering 700 cubic meters (154,000 gallons) per hour each, were added. Steam of four atmospheres pressure is furnished to the engines Nos. 1 to 4 by seven Lancashire boilers, the total heating surface being 477 square meters (5,135 square feet).

In 1888 another pair of pumping engines was completed, delivering 900 cubic meters (198,000 gallons) per hour each. These are compound engines with two cranks at right angles, each piston rod driving a pressure pump and a filter pump placed tandem. These engines have got Sulzer trip gear for the steam valves of both cylinders. The pump valves are also lifted mechanically—Riedler's system; this arrangement involving sixteen sets of eccentrics and levers for each engine.

Steam of six atmospheres for these compound engines is produced by three Cornish boilers with corrugated

furnaces. Total heating surface, 252 square meters (2,713 square feet).

These engines have been run during eight years, and have done their work perfectly well; only the coal consumption has proved to be somewhat in excess of what was guaranteed. The contract stipulated a consumption of one kilo. (2·205 lb.) of coal for each "water horse power" per hour, a "water horse power" being the power required for actually lifting 4·5 cubic meters of water per minute against one meter head.

The water consumption steadily increasing, the construction of new engines was again contemplated in 1893. In order that the filter pumps might be run quite independently of the pressure pumps, separate engines were required: three vertical direct acting triple expansion engines, each driving a centrifugal pump for delivering 1,560, 1,020, and 540 cubic meters per hour (343,000, 224,000, and 119,000 gallons); and two horizontal engines with pressure pumps for 1,500 cubic meters (330,000 gallons) per hour each. As far as we know, this is a larger quantity than is delivered by any waterworks pumping engine on the Continent. The centrifugal pumping engines were ordered of Messrs. Diepeveen, Lels & Smit, of Kinderdyk, Holland.

For the pressure pumping engines a competition was held between nine firms that were best known for first-class pumping machinery. The offer of the Fyenoord Engine Works was accepted, as it promised the highest steam economy, the Fyenoord Works requiring for the engines offered only 7·95 kilos. (17·53 lb.) per water horse power per hour, a figure far less than any of the other competitors guaranteed. Should the steam consumption prove to be greater than the stipulated quantity, the engine works would have to pay a penalty of 40,000 guilders (£3,333) for every kilogramme in excess, no premium being granted for a smaller consumption.

Before proceeding to give a description of these engines, we will at once say that the actual steam consumption has proved to be far less than was stipulated. The committee who conducted the official trials stated for one of the engines an actual steam consumption of only 6·635 kilos. (14·628 lb.) per water horse power per hour, this being the lowest consumption on record for pumping engines of so small a lift as only 30 meters (98 ft. 5 in.)

The engines are of the surface condensing triple expansion type, with three cranks at 120 deg., each piston rod driving a double acting pressure pump. The principal dimensions are the following:

Diameter of H. P. C.	400 millimeters	= 15¾ in.
Diameter of I. P. C.	620 "	= 24⅜ in.
Diameter of L. P. C.	920 "	= 36¼ in.
Stroke	900 "	= 35⅜ in.
Diameter of main bearings	230 "	= 9 in.
Length of main bearings	350 "	= 13¾ in.
Diameter of fly wheel	3,500 "	= 11 ft. 5¾ in.
Breadth of rim of fly wheel	330 "	= 12⅞ in.
Cooling surface in condenser	45 sq. meters	= 457 sq. feet.
Diameter of air pump	320 millimeters	= 12⅝ in.
Stroke of air pump	280 "	= 11 in.
Diameter of feed pump	70 "	= 2¾ in.
Variable stroke of feed pump, from 121 to 295	"	= 4¾ in. to 11⅝ in.
Diameter of main pump plungers	390 "	= 15⅜ in.
Stroke of main pump plungers	900 "	= 35⅜ in.
Diameter of piston rod	90 "	= 3⅝ in.
Diameter of valve rings, from 220 to 820	"	= 8⅝ in. to 32¼ in.
Number of revolutions	44 per minute.	

The horizontal double acting air pump under the floor is driven from the overhung low pressure crank pin. The surface condenser is supported by the air pump and by the inlet pipe of the circulation water. A special circulating pump is not provided, as part of the unfiltered water from the centrifugal pumps above mentioned is used for circulation before being delivered on the filters.

The casting for each bed plate carries the shaft, the cylindrical guides for the crosshead, and a flange or rim on the after end to which the cylinder is bolted. This bed plate is firmly secured to the foundation by means of holding-down bolts, vertical and diagonal.

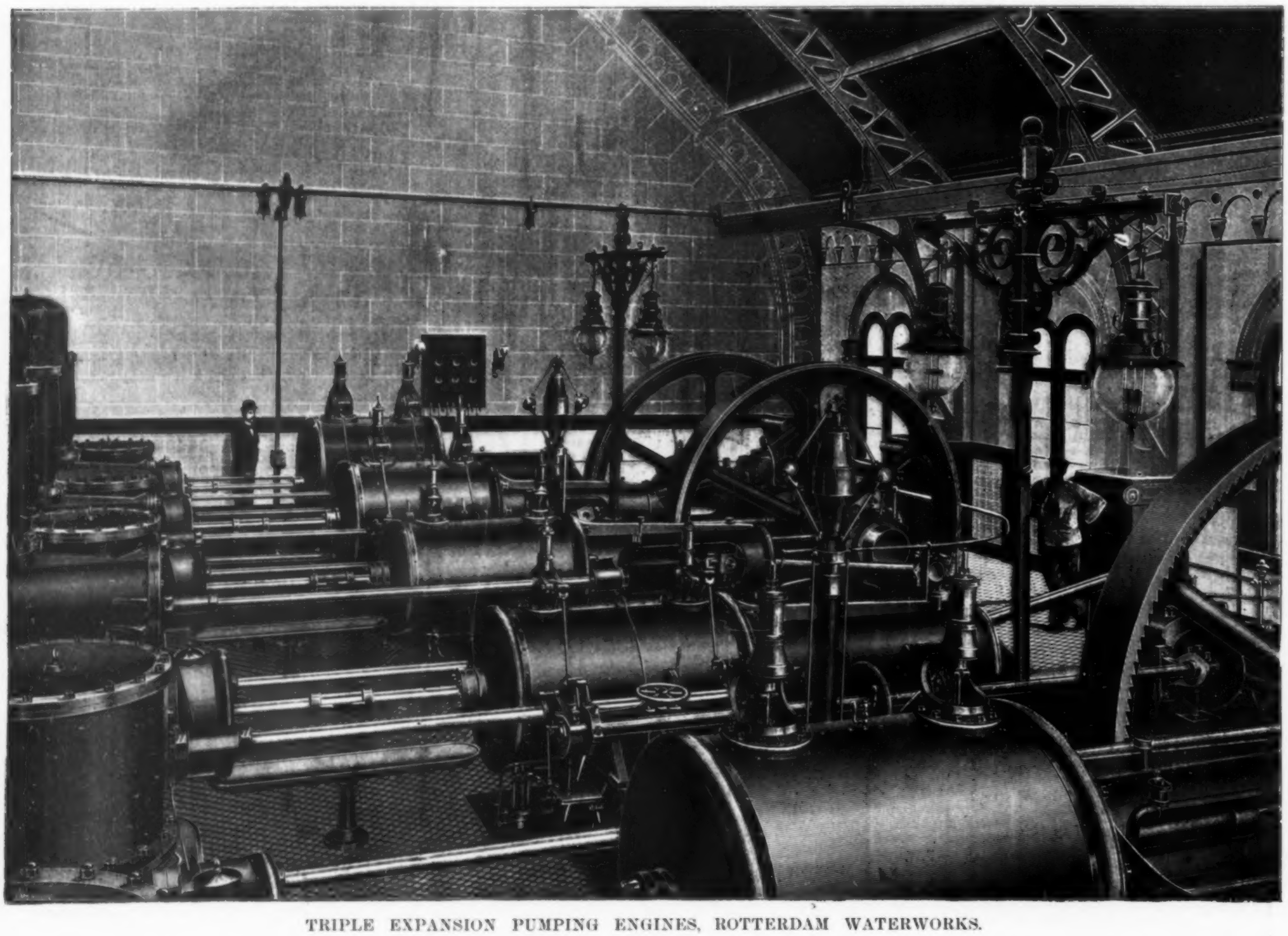
Each engine frame is connected to the front cover of the corresponding pump by two 3¼ in. bars passing on each side of the steam cylinder, which has no foundation bolts itself, it being merely supported by cast iron beams, and free to expand when steam is put on. The inlet valves are at the top of the cylinders, the outlet valves at the bottom; they are worked from a shaft alongside each cylinder, driven from the main shaft by bevel gearing. The steam valves have no trip gear, which would involve the use of dashpots, shifting valves, etc., but they are simply lifted by a lever that supports the valve till the moment it touches the seat. A sharp cut-off can be thus attained by carefully proportioning the levers. The admission to the high pressure cylinder is regulated automatically by a Porter governor, whereas the admission to the intermediate pressure and low pressure cylinders can only be changed when the engine is stopped. The governor is driven by toothed gearing from the same shaft that works the steam valves of the high pressure cylinder. The ordinary speed of this governor is 157 revolutions per minute, and it is worth mentioning that the teeth are so accurately cut that not the least noise is heard when running at full speed. The central weight of the Porter governor can be lifted by tightening a spiral spring. In this way the number of revolutions of the engine can be reduced from forty-four to eighteen per minute simply by turning the hand wheel, and brought into accordance with the water consumption in the city at any time. The cylinders as well as the covers and the receivers are steam jacketed, the latter being provided with brass tubes through which the steam passes on its way from one cylinder to the next, the pipes being heated with live steam from the outside.

Steam enters through the main stop valve into the jacket of the high pressure cylinder. From this jacket it is admitted to the cylinder by the inlet valves at the top, while the steam for heating the first receiver is taken from the bottom. From the bottom of receiver jacket No. 1 heating steam is conducted to the jacket of receiver No. 2; the latter jacket is drained by a steam trap. This arrangement involves the use of only one steam trap and secures a perfect drainage of the jackets.

The working steam that has been reheated in passing through the pipes of receiver No. 1 enters into the jacket of the intermediate pressure cylinder somewhat superheated, and is still perfectly dry when admitted into this cylinder. Therefore no drainage is necessary for this cylinder jacket. For the low pressure cylinder conditions are exactly the same as for the intermediate pressure cylinder. All parts of the cylinders which come in contact with steam performing work are carefully turned and polished. Great care was bestowed on the construction of the horizontal air pump, the result being that while the capacity of this pump is only $\frac{1}{17}$ of the low pressure cylinder, yet the vacuum in the condenser is usually 28¼ in., measured by a mercury gage, and reaches even 29 in. on some days when the barometer is high.

The pressure pumps are of the Girard type, each double acting pump consisting properly of two single acting pumps placed face to face, and worked by a common plunger. The bed plate of each pump is cast hollow and used as a suction air vessel, the air space of which is enlarged by a vertical dome. The water delivered by the three pumps passes through a horizontal air vessel 1,100 mm.—3 ft. 7¼ in.—diameter, 8,070 mm.—26 ft. 5¾ in.—long, from which it is directed downward through the pressure main of 20 in. inside diameter. The weight of this air vessel, about 8½ tons, water included, is supported by the vertical domes.

The Riedler system for working the pump valves mechanically was not adopted, the only advantage of this system, viz., small dimensions, great water velocities and yet no shocks, being of no consequence in this case. The stipulated steam consumption necessitated a reduction of the velocity through the pump valves as far as practicable in order to avoid losses by friction, etc. That the complication of the numerous eccentrics, levers, bearings, etc., to work each pump valve separately was thus avoided, was considered an advantage.



TRIPLE EXPANSION PUMPING ENGINES, ROTTERDAM WATERWORKS.

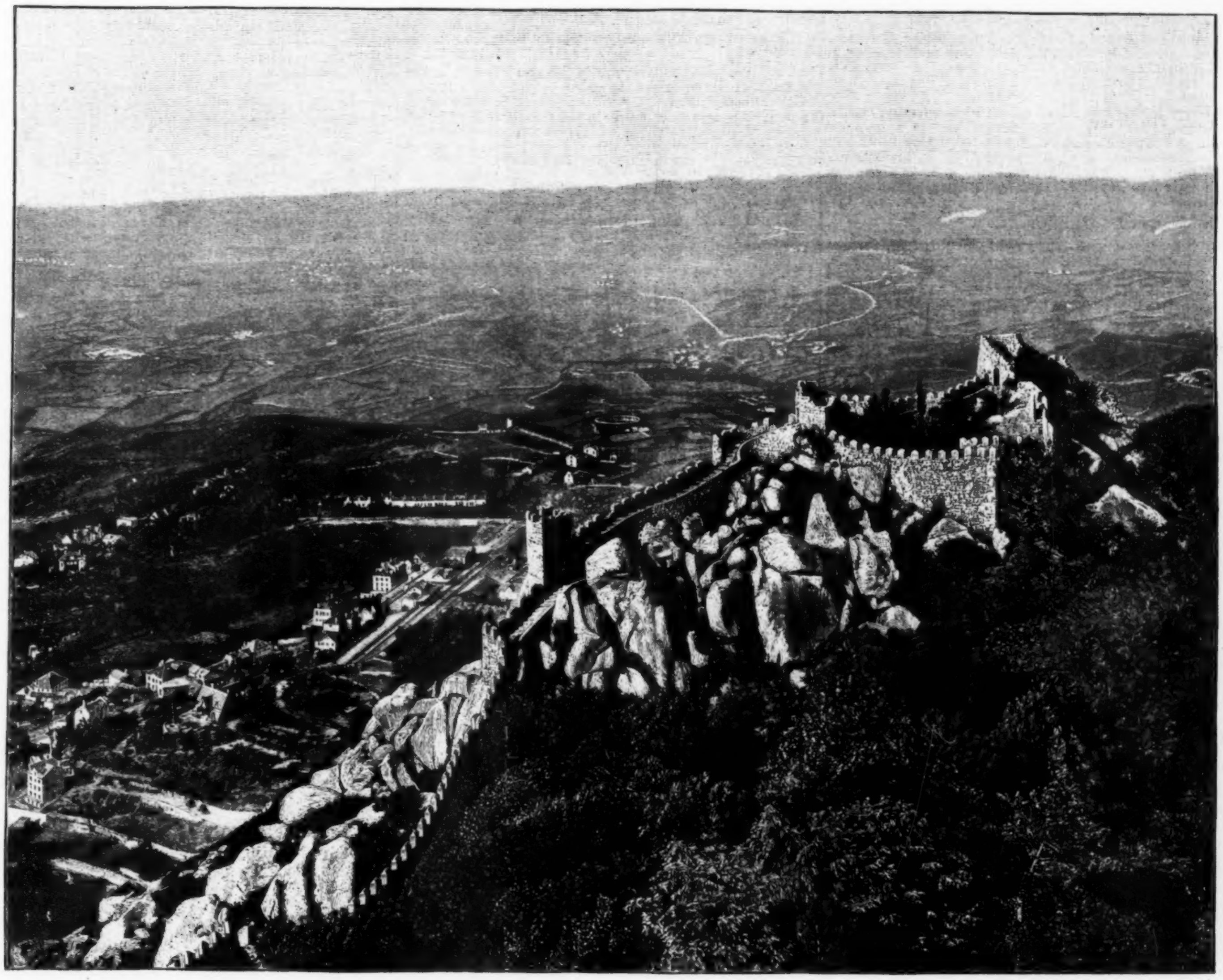
The pump valves consist of seven bronze rings of 220, 320, 420, 520, 620, 720, and 820 millimeters diameter (seven rings 8⅝ in. to 32¼ in. diameter) working on cast iron seats. Above each valve is a small air dome. The valves work very smoothly, even at fifty revolutions per minute, and are so perfectly watertight that the pumps deliver only two per cent. less water than the theoretical displacement of the plungers.

The official trials of the engines were conducted by a special commission consisting of Messrs. H. A. Ravenek, Professor of the Engineering Academy at Delft, Y. De Koning, C.E., and W. F. D. Van Ollefen, Surveyor to Lloyd's Register. The water delivered per revolution of each engine was measured in the main high level tank of the waterworks, which has a capacity of 1,500 cubic meters (330,000 gallons). The steam consumption was ascertained for each engine during a six hours' trial by weighing the feed water required to maintain a constant level in the boilers, a donkey pump driven from a separate boiler being used for feeding. The water from the separator or filter in the steam pipe was collected and weighed, this weight being deducted from the total feed water used. Of course the water from the jackets was not deducted. The pressure in the city main was measured by an open mercury gage on the air vessel, 1 ft. of mercury representing 13·574 in. of head, at a temperature of 62 deg. Fah. This head, added to the difference between the level in the main air vessel and the level in the suction basin, gave the total lift.

THE MOORISH CASTLE AT CINTRA.

SOME hours west of Lisbon, Portugal, a picturesque line of hills rises to 2,000 feet or so, extending in length over about fifteen miles. Gigantic blocks of granite cover the ground, often grotesquely strewn about, as if by the hands of a giant. On the eastern and southeastern slopes the dry land winds permit practically no vegetation to spring up; thorns, heather and bare rock—nothing more. But on the northwestern and northern descents, which are touched by the damp sea breezes, it is very different. Here we find numerous springs, which, breaking forth to daylight, spread life and fragrance as they flow to meet the brook that takes their crystal waters on to the wide ocean.

In this hill country lies the little town of Cintra, the last station of the railway from Lisbon. Over it rises a steep rock, crowned with a fort, the Moorish castle. Oft taken but never destroyed during the long wars with the Saracens, its turrets and pinnacles still look defiance over the depths. The fort consists of a long circular wall, which, mounted with turrets at short intervals, surrounds the whole summit with all its woods and rocks. From there the eye sweeps over the wooded descents of the Serra de Cintra to the Tejo, and beyond the Tejo to the blue Serra de Arrabida. In the north distant mountain chains bound the horizon, and at their foot are visible the great cloister of Mafra and the



THE MOORISH CASTLE AT CINTRA.

castle of the same name. Toward the west a few villages gleam white in the sun, and beyond stretches the ocean's unbounded expanse, which through a broad portal of hard rock breaks on the sands of the Praia de Maças.

When the first days of July have arrived, and dust and heat are becoming unbearable in Lisbon, when in a southerly wind the low stand of the river infects the air around, then all the fashionable inhabitants of the capital resort to Cintra. Elegant carriages and well dressed people fill the streets; on the market place the donkey drivers are thronging, and noisily offer their beasts to the tourists. The early train on Sunday brings a colony of beggars. They arrive decently dressed; an hour after, wrapped in rags, they are begging for alms in the dust of the high road. In the palace garden there is music every night from nine till ten. In the afternoon it is a constant life and strife on the roads leading to Collares, where park follows park. Carriages rush past; with a four-in-hand and a forerunner the queen dowager drives past, accompanied by the Prince Alfonso, stately and cool in her response to the respectful salutations; an hour later the youthful queen, Donna Amelia, who bows amiably to the public on all sides.

Thus the beauties of nature are allied with the charms of distinguished society, and this combination makes Cintra an ideal summer resort.

For our engraving we are indebted to Ueber Land und Meer.

CONTRIBUTIONS TO THE BIBLIOGRAPHY OF PHOTOGRAPHY IN COLORS.

By THOMAS BOLAS, F.C.S., F.I.C.

IN view of the recent interest taken in heliochromy, the following may possibly be of value to the experimenter as showing him where to find record of the work of others.

It must not be regarded as even approximating to completeness, but it may serve as a beginning to which others may add, and thus become the basis of a tolerably exhaustive index to what has been published.

1810. T. J. SEEBECK.

Referred to in Goethe's "Farbenlehre" and in Hunt's "Manual of Photography" as having noticed the local colorization of chloride of silver under the spectral rays; brown to violet and blue in the violet rays, blue in the blue rays, and red in the red rays.

1829. I. NICEPHORE NIEPCE.

Documents deposited with Daguerre in relation to his partnership, and published in 1839 by order of French government. Following from letter by Niépce, dated December 5, 1829. The English translation is from the "History and Practice of Photogenic Drawing" (I. S. Memes, London, 1839), this book being a translation of the official publication regarding daguerreotype and collateral matters, by the French government.

Niépce details the results of exposing a glass plate coated with bitumen in the camera, and says: "If this landscape be viewed by reflection in a mirror, on the varnished side, and at a certain angle, the effect is striking, while, seen by transmission, it presents only confused and shapeless imagery; but what is really surprising, in this position the mimic tracery seems to assume the local colors of certain objects." Niépce theorizes on the subject and compares the colors to those of Newton's rings.

1839. SIR JOHN HERSCHEL.

In this year commenced the series of papers read before the Royal Society by Sir John Herschel on photographic processes. The most important appeared in the "Philosophical Transactions," 1840. In this he describes the character of the colored spectral image obtained on paper sensitized with silver chloride (Talbot's process) and refers to the "possible future production of naturally colored photographic images." It was followed by another in 1842, and later by others. Sir John Herschel also published the results of some of his researches as communications to the British Association, but unfortunately the association reports are very meager. One of these (1841) accompanies a collection of "colored photographic copies of engravings and mezzotints, into the preparation of which no metallic ingredients enter, the whole being tinted with substances of vegetable origin." The method, says the author, "holds out no slight hope of a solution of the problem of a photographic representation of natural objects in their proper colors." In another (1839) he refers to his observation (apparently announced about June or July, 1839) that colored images of the spectrum could be obtained on sensitized paper.

1844. ROBERT HUNT.

Hunt devotes a chapter in his "Researches on Light" to "the probability of producing colored pictures by the solar radiations," and describes the production of colored images on chloride of silver paper. He also (page 105) states that he had obtained a colored image of the spectrum on paper prepared with nitrate of silver and fluoride of soda. He mentions that Sir John Herschel was the first to obtain "any good specimens of photographically impressed prismatic colorations." This book contains the results of researches previously published in various papers to the Royal Society, the British Association, etc., 1840 to 1844.

1848. ED. BECQUEREL.

Comptes Rendus de l'Académie des Sciences, Paris, 22 (1848) 181, 27, 485.

Discusses the colors produced by spectral rays on chloride of silver, and describes various methods of obtaining spectral impressions on chlorinized silver plates. The subject is further treated of in his text book on light, published in 1867.

1851. NIEPCE DE ST. VICTOR.

From 1851 to his death, in 1870, published many details as to the obtaining of colored images on silver chloride, but, like those obtained by Becquerel, they were unfixed. His last paper is to be found in the Comptes Rendus for 1866.

1855. TESTUD DE BEAUREGARD.

I gather the following, not from the original sources, but from Herr Hermann Krone's book, "Die Darstellung der Natürlichen Farben durch Photographie," Weimar, 1894.

At a meeting of the Société Française de Photographie held in 1855 (see Bul. Soc. Fran. Photo., 1855, page 153; Phot. Soc. Journ. II, 1856, pages 195–197), Beauregard exhibited prints showing the colors of the original objects, which photographs had been obtained by exposing a sensitive surface to white light under what appeared to be a monochrome negative (collodion) in which it was claimed the colors were latent. The latent colors, whether in fixed negative or print, could be called forth by using special preparations or solutions. The following are mentioned: a silver solution, chromic acid oxide of chromium (presumably a salt), sulphate of iron, gallic acid. Baths used in the first preparation of the paper were perman-

ganate of potassium to which litmus had been added, and ferricyanide of potassium to which sulphuric acid had been added. Next the paper was sensitized with a silver solution, exposed, fixed with hyposulphite, and a bath of ammonium gallate was then used.

In some cases the colors on the print appear to have been produced in the printing frame, the subsequent treatment having served to increase their vigor, but the particulars given are obviously too incomplete to serve as an exact guide to other workers; Zenker, for example, having failed to produce colored effects. M. Durieu, who occupied the chair, distinctly certified that he had seen the colors produced by printing under the collodion negative. MM. Durieu, Becquerel, Regnault, Silbermann, and others, concluded that the negative could not be a true monochrome, and Silbermann believed he could recognize it as colored. In a later communication to the French Photographic Society (April 17, 1857), M. Beauregard said that when a glass plate coated with a chlorinized collodion receives a short exposure to a colored image, such as is given in taking an ordinary negative, very often a negative is produced in which the colors are latent, but capable of development by suitable toning agencies. He further says that if such an image is fixed in cyanide, dried in the dark and exposed to slightly chlorinated iodine fumes, the colors gradually appear and gain in intensity, but the exposure to the vapor must be broken off now and again to expose the picture to sunlight. An acid solution of gold chloride may be used at this stage.

Beauregard failed to completely reproduce the spectrum, and considers that white light is an essential in his method of working.

1858. Thompson (of Ross and Thompson, Edinburgh).

Sutton in his "Dictionary of Photography," 1858, page 299, says: "We must refer the reader to a pamphlet published by Mr. Thompson (of Messrs. Ross and Thompson, Edinburgh), for particulars of various experiments which have been made by different persons with a view to the discovery of photography in natural colors."

1859. Alcide Ducos du Hauron.

In "La Triplice Photographique des Couleurs et l'Imprimerie, Système de Photochromographie," Paris, 1897, Alcide Ducos du Hauron gives a very full summary of the method of his brother Louis Ducos du Hauron, and a list of his various publications regarding heliochromy and other subjects. The first item in this list is:

"20 Janvier, 1859. Communication à la Société des Sciences et Arts d'Agen d'une Memoire fort etendu ayant pour titre; étude sur les sensations lumineuse."

The second item is:

"14 Juillet, 1862. Communication à M. Lélut, Membre de l'Institut, d'une Methode de reconstitution photographique des couleurs par triple tamisage des rayons et par triple reversion d'empreintes."

1865. H. Collen.

British Journal of Photography, 1865, page 547.

As an early suggestion as to three-color heliochromy, Collen stated the problem as the making of three negatives by the blue, red, and yellow rays respectively, taking a film print from each of these in the color which produced the negative, and superimposing the film prints.

1866. Alphonse Louis Poitevin.

Communications to French Photographic Society, January 12, 1866, and December 7, 1866.

Observation on the direct rendering of color on silver chloride or subchloride.

1866. G. Wharton Simpson.

Photographic News, 1866, page 73.

"Collodio-chloride of silver was prepared with the slightest possible excess of silver nitrate, and a plate of opal glass coated with this was dried before a fire and exposed to daylight until it had become lavender gray or slate color. This was exposed for some hours to sunlight. Where film was uncovered the film became bronzed black, where covered with colorless or yellowish glass it became yellowish white, where covered by ruby glass claret or magenta colored; under orange glass the film took a somewhat redder tint than that of the orange glass, under white glass covered with aniline red the tint ranged from orange to deep purple red, and under glass coated with aniline green the film became deep green.

1867. Charles Cros.

In a French patent, December 2, 1867, set forth a theory of three-color heliochromy independently of Ducos du Hauron, but he suggested taking the three negatives by red, yellow, and blue light. The elements of the chromogram were to be united by means of a kind of zoetrope.

1867. Niepce de St. Victor.

Showed in the Paris Exhibition of that year some color photographs. Vogel's "Chemistry of Light," etc., says they were shown in half-closed boxes, in subdued daylight, and lasted about a week.

1868. Louis Ducos du Hauron.

French patent, 83,061, of November 23, 1868.

The specification describes the three-color method with three negatives, also with a single plate exposed behind a screen ruled or plotted out in three colors.

1868. Dr. Wilhelm Zenker.

Lehrbuch der Photochromie. Berlin, 1868. Published by the author.

Is said to contain the theoretical aspect of what is known as the Lippmann process. I have not seen the book, but frequent reference is made to it in Wiener's Memoir on Heliochromy, Lippmann's original paper, and other publications.

1869. Louis Ducos du Hauron.

Les Couleurs en Photographie. Solution du Problem. Paris, 1869. A. Marion.

This contains an account of the three-color process in its various forms, the fundamental position being to take the negatives under screens corresponding to the Young-Helmholtz color sensations, and to make a print with transparent coloring materials having complementary tints. A method with a screen ruled in three colors, and similar to that now known as the Joly method, is described.

1873. G. W. Simpson.

The Influence of Colored Light on the Tone of Prints. Photographic News, 1873, page 246.

1876. Louis Ducos du Hauron.

English patent, No. 2,973, of 1876.

Describes the three-color method, also special camera with reflectors for taking the three images and similar device for viewing.

1876. Dr. Hermann Vogel.

Devotes a chapter of his "Chemistry of Light and Photography" (International Scientific Series) to the subject of photography in natural colors. It is a short historical sketch of the subject.

1878. A. & L. Ducos du Hauron (Frères).

Traité de Photographie des Couleurs. Système d'Heliochromie. Louis Ducos du Hauron. 108 pages. Paris, 1878. Gauthier-Villars.

The work includes color-corrected sensitive plates, but, in other respects, is not very different from Louis Ducos du Hauron's book of 1869.

1879. Captain W. de W. Abney.

Proceedings of the Royal Society, xxix, 190; xxxiii, 164.

A study of the production of colors on silver chloride, especially on a chlorinized daguerreotype plate. Abney finds that peroxide of hydrogen, before or after exposure, brings about a more rapid production of color, and he shadows forth (1879) Wiener's recent theory as to the several forms of silver haloid which may be specially absorbent of various spectral rays.

1879. J. M. Eder.

Uber die Chemische Wirkungen des Farbigen Lichtes und die Photographie in natürlichen Farben. 68 pages. Wien, 1879. Verlag der Photographischen Correspondenz (Dr. E. Hornig).

1881. Charles Cros.

Moniteur de la Photographie, 1881, page 64. "Hydrotypie et Polychromie Immediate."

The colored image—that of the camera, for instance—is received on a chromo-sensitive surface composed of red, yellow and blue superimposed or juxtaposed, the coloring materials being so selected that each is destroyed by complementary radiations. Thus, the orange rays destroy the blue pigment, the green rays destroy the red pigment, and the violet rays destroy the yellow pigment. On glass we have first collodion colored red by cartharnine, then gelatine colored blue by phyllocyanine, and finally collodion made yellow by curcuma.

1883. Captain W. de W. Abney.

English Edition of Eder's "Chemical Effect of the Spectrum." London, 1883. Harrison.

Abney's footnotes often throw a new light on matters bearing on heliochromy.

1884. E. Liesegang.

Die Heliochromie; das Probtem des Photographirens in den näturlichen Farben. Düsseldorf, 1884. Liesegang's Verlag.

A summary of early work, more especially that of Niépce de St. Victor, Becquerel, and Poitevin.

1886. F. E. Ives.

Iso-chromatic Photography with Chlorophyl. Philadelphia, 1886. Printed by the author.

This work contains much miscellaneous information showing how the author was led to a study of theoretical and practical heliochromy.

A New Principle in Heliochromy. Philadelphia, 1889. Published by the author.

Deals with the fundamental principles of heliochromy.

Handbook of the Photochromoscope. London, 1894. Simpkin, Marshall, Hamilton, Kent & Company.

Papers read before the Society of Arts and the Camera Club on his Photochromoscope. Journal of the Society of Arts, vol. xl (1892), page 687; vol. xli (1893), page 663. Camera Club Journal, Feb., 1897, page 23.

1887. M. Carey Lea.

On red and purple chloride, bromide, and iodide of silver; on heliochromy, and on latent photographic image. American Journal of Sciences, May, 1887 (Third Series, vol. xxxiii, page 34). Photographic News, 1887, page 326.

Describes the production by chemical means of colored haloid salts of silver, which he terms photo-salts. As bearing on Wiener's theory of body color heliochromy with one surface, the following extracts may be made:

"Exposed to ordinary diffused light air the bright shades of silver photo-chloride quickly change to purple and purple black. The darker shades are more slowly influenced."

RELATIONS OF PHOTO-CHLORIDE TO HELIOCHROMY.

"The photo-chloride was examined both with the spectrum and under colored glass. The rose-colored form of photo-chloride was that which gave the best effect. In the violet of the spectrum it assumed a pure violet color, in the blue it acquired a state of blue, in green and yellow a bleaching influence was shown, in the red it remained unchanged. The maximum effect was about the line F, with another maximum at the end of the visible violet, less marked than the one at F.

"Under colored glass the colors obtained were brighter; under two thicknesses of dark ruby glass the color became brighter and richer. Under blue glass some specimens gave a fair blue, others merely gray. Under cobalt a deep blue was easily obtained, and under manganese violet a fine violet, very distinct in shade from cobalt. Green produced but little effect; yellow was sometimes faintly reproduced, but rarely. But the yellow glass of commerce lets through portions of nearly the whole spectrum, as can readily be seen by testing it with the spectroscope.

"Hardly two specimens of photo-chloride give exactly the same results with colored lights, and this suggests great possibilities.

"Evidently an important point in all heliochromic processes is that white light must be represented by white in the image. It is an essential condition that white light must exert a bleaching action on the sensitive substance employed. Red chloride of silver does not bleach, but darkens in white light; but the property of bleaching, to a very considerable extent, may be conferred on it by certain other chlorides, and particularly by lead chloride and zinc chloride.

"I am persuaded that in the reactions which have been here described lies the future of heliochromy, and that in some form or other the beautiful red chloride is destined to lead eventually to the reproduction of natural colors."

1888. Germeuil-Bonnaud.

Patent specification, No. 1751, February 6, 1888, quoted in Photographic News, 1889, page 458.

A sensitive mixture is prepared, e. g., with 100 c. c. water, 20 grammes treacle, 10 grammes borate of soda, and 5 to 20 grammes of bichromate of potash. A surface (e. g., glass) coated with this is dried, exposed under a positive and dusted with various colored pigments, that representing the general shade being first used. The colors are stated to adhere discriminatively, reproducing the original scene, although as far as can be gathered a monochrome positive is used. Details as to transfer and vitrifying of pictures are of no special interest.

1889. C. V. Boys.

Photographic News, 1889, page 458. Report on a dusting process of Germeuil-Bonnaud.

The dusting process of Germeuil-Bonnaud appears to possess no very fundamental difference from other "dusting-on methods," using the term in the ordinary sense, but this inventor claims that dusting-on colors adhere so as to reproduce the tints of the original with more or less fidelity. Mr. Boys, in his report, says:

"The colors do not appear to adhere indiscriminately, but to fall into their proper places as if directed by an unseen hand. For instance, in a landscape that I saw copied by this process the blue powder was first dusted on and then a suitable shade of green. On examination it was found that the sky was blue and the leaves of the nearer trees green, while the more distant trees were of a slightly different shade, giving the effect of distance perfectly."

It appeared, however, doubtful whether this was due to a selective action or to the various "tackiness" of different parts of the film.

1889. Otto Wiener.

Wiedemann's Annalen, 1st vol. of 1890 (New Series XL), page 203. Stehende Lichtwellen und die Schwingungs-Richtung Polarisirten Lichtes (a paper read at the 1889 meeting of Deutscher Naturforscher und Aertze, reported on page 209 of the official proceedings (Tageblatt der Versammlung).

The author desired to demonstrate the existence of standing or stationary waves when interference occurs, by some means comparable to that adopted by Hertz in the case of Hertzian light; and after a review of the various reactions of light available for the purpose of obtaining a record, he concluded that photo-chemical action would be most suitable.

Obviously the ordinary gelatine plate would be out of the question, as, apart from its opacity, the thickness of the film would be enormous in relation to the work in hand; indeed, this thickness would have to be expressed in hundredths of a millimeter, and several hundred wave fronts could be ranged as a series in the thickness of the film. It was, therefore, necessary to seek for some photographic film which should not only be transparent, but the thickness of which should be fairly small in comparison with a wave length. The author then found that Zenker had, in or before 1868, attempted to obtain records of standing or stationary waves on a thin photographic film as a means of solving the problem of photography in natural colors.

The author, by the following means, obtained a transparent film having a thickness of from one-twentieth to one-fortieth the wave length of sodium light.

Collodio-chloride of silver as sold in two preparations by Schippang & Company, of Berlin. The two constituents of this preparation (the general nature of which is well known to photographic practitioners) were diluted with from 15 to 20 volumes of alcohol and mixed. To obtain a film of the required tenuity on a glass plate, a few drops were poured on a flat glass, another glass was brought down on the fluid quickly so as to spread the fluid, after which the glasses were separated and dried in a horizontal position. The coated plate can hardly be distinguished from an uncoated plate; indeed, the liquid preparation used appeared clear like water, and must be looked on rather as a solution than as an emulsion. In one case, three drops of a nineteen times diluted preparation covered 35 square centimeters of glass, and experiment showed the thickness of the film to be only one-thirtieth of the wave length of sodium light; the means adopted being to scrape away a little of the film, lay on another glass, and deduce the thickness from the interference phenomena of the air space. This experiment was checked by a calculation based on the known solid contents of the sensitive solution or emulsion. Thinly silvered glass plates subsequently exposed to the fumes of iodine were also used.

The transparent sensitive film on glass being now placed in contact with or at slight inclination to a silver on glass reflector, interference effects were recorded on the film in accordance with the theory of standing or stationary waves, spectral or other light being used.

1889. Raphael Meldola.

In his "Chemistry of Photography" gives a short general sketch of the subject of photochromy, and de-

scribes a method by G. Staats (quoted from the Ber. Deutsch. Chem. Gesell., 1887, page 2322) of producing colored images on silver chloride.

1890. E. De Saint Florent.

Bulletin de la Société Française de Photographie, 1890, page 229.

Paper is coated with collodion containing nitrate of silver, and the dry film is treated with hydrochloric acid, after which sufficient exposure to light is given to give a deep bluish tinge. If now saturated with a solution of nitrate of mercury, it will take the colors of a superimposed transparency by an exposure of a few minutes. A solution of one part of ferric chloride in about thirty of water partially fixes the colored image.

1890. F. Veress.

Photographic News, 1890, page 276.

An account is given of reproductions in color. Collodio-chloride of silver is treated in some special way (not stated) and upon it are obtained prints showing extremely brilliant colors, but apparently not altogether true to the original, green being absent.

1891. Alphonse Berget.

Photographie des Couleurs, par la methode interferentielle de M. Lippmann, 58 pages, Paris, 1891, Gauthier-Villars et Fils.

A concise historical, theoretical and practical account of interference heliochromy.

1891. G. Lippmann.

Comptes Rendus, cxii, page 274. (1891.)

The now celebrated method of exposing a structureless sensitive film with a reflecting surface of mercury behind it, stated to be based on the theory of heliochromy set forth by Zenker in 1868 and later by Rayleigh, and on Wiener's demonstration of stationary waves.

Further observations, Comptes Rendus, cxiv, 961; cxv, 575. Proceedings Royal Society, vol. lx, page 10. Proceedings Royal Institution, April 17, 1896.

1891. Dr. W. Zenker.

Eder's Jahrbuch, 1891, pages 294-303; 1893, pages 114-121.

In these memoirs the author discusses the various methods—especially the interference methods—from theoretical points of view, and defends the Lippmann-Zenker theory against the criticism of Dr. Stolze and others.

1892. G. Meslin.

Mentioned by Bothamley in "Photography Annual," 1893.

Use of a bichromated albumen or gelatine film as in the Lippmann method, reduction taking place at the maxima of the stationary waves and the colors appearing on moistening or wetting the film.

1892. E. de Saint Florent.

Bulletin de la Société Française de Photographie, 1892, page 661.

Ordinary gelatino-bromide plates exposed under a colored original, and fixed without being developed, give color images, the transmission colors being complementary to those by reflection, but such colors usually disappear on drying the plate. Better results are obtained by treating the plate with nitrate of silver before exposure. Similar results on bichromated colloid films are described.

1893. A. and L. Lumiere.

Bulletin de la Société Française de Photographie, 1893, page 249.

Describes the preparation of a fine textured gelatino-bromide emulsion for the Lippmann process.

1893. Edward Valenta.

Photographische Correspondenz, 1893, page 577.

Emulsion for and details of working the Lippmann method.

1894. Eug. Dumoulin.

Les Couleurs reproduites en Photographie. Deuxième Edition. 58 pages. Paris, 1894. Gauthier-Villars et Fils.

A short general account of chief methods, with some historical notes.

1894. H. Krone.

Die Darstellung der Natürlichen Farben durch Photographie, 120 pages, Weimar, 1894, K. Schwier.

Lippmann's method is referred to as subject to certain false renderings by moisture in the film and other conditions. The use of the mercury mirror, though requisite when the best results are required, may, however, be dispensed with. Exposure beyond that required lowers the purity and intensity of the colors. This work is a very carefully written history of heliographic experiments and research.

1894. R. Neuhauss.

Photographische Rundschau, 1894, pages 295, 328 and 360.

Discusses details and working of the Lippmann method—the method, if properly carried out, rendering colors satisfactorily. Light beyond the range of the visible spectrum, whether infra-red or ultra-violet, sometimes causes a green coloration, and a similar appearance is sometimes noticeable where the exposure has been inconsiderable.

1894. Eduard Valenta.

Die Photographie in Natürlichen Farben mit besonderer Berucksichtigung des Lippmannschen Verfahren, 79 pages. Halle a. S., 1894, Verlag von Wilhelm Knapp.

This work is one of especial interest, as including the results of researches and experiments by the author.

1894. Dr. H. W. Vogel.

Das licht im Dienste der Photographie. Berlin, 1894. Oppenheim.

In this work, pages 134-249, and in other places, is much original and collated information bearing on heliochromy.

1894. E. J. Wall.

Gave two lectures on Photography in Colors before the affiliated photographic societies. These are published in the Photographic Journal, 1894, pages 245 and 290; and in the Amateur Photographer, June 22 and July 20, 1894.

1895. A. Berthier.

Manuel de Photochromie Interferentielle. 169 pages. Paris, 1895. Gauthier-Villars.

1895. J. Joly.

Method of Photographing in Natural Colors. A paper read before the Dublin Royal Society, June 26, 1895. Transactions, vol. vi (Series II) and British Journal of Photography, December 6, 1895, page 774.

General considerations on the three-color process. Special reference is made to that form of the process in which one sensitive plate is used, and in front of this is placed a screen ruled in three colors, a screen not quite similar being used in viewing a positive from the resulting negative.

The screen for taking the negative is described as orange, green and violet; while the viewing screen is described as red, green and violet. The author does not appear to explain his preference for orange in taking that element of the negative corresponding to the red sensation, but presumably his reasons are similar to those which led Louis Ducos du Hauron in 1868-69 to prefer an orange screen to a red screen in making up the triplet of red, green and violet (see p. 41 of Ducos du Hauron's "Couleurs en Photographie," Paris, 1869, Marion). It is interesting, however, to note that Ducos du Hauron's earlier proposal as regards the ruled screen (see page 56 of the work mentioned) differed somewhat from those of Dr. Joly. In a note addressed to the Photogram, March, 1897, Professor Joly, without giving particulars, somewhat vaguely says: "The screen used in obtaining the negative is not lined in the same colors as are borne upon the screen ultimately used in viewing the positive. The first screen carries the three colors requisite to give densities of image upon the plate corresponding with the degree in which the various wave lengths affect our three-color sensitive nerve systems. The viewing screen carries the three fundamental sensation colors, which alone are excited in, or conveyed by, the nerves."

1895. Auguste and Louis Lumiere.

Revue Général des Sciences Pures et Appliquées. December 15, 1895.

Application of diazotype for making the elements of the three-color heliochrome.

1895. R. Neuhauss.

Photographische Rundschau, 1895, page 353.

Mercury used in Lippmann's process appears to exercise a deleterious action, and the film should not remain in contact with it longer than is necessary; moreover, the plate should be developed as soon as practicable after exposure.

1895. G. H. Niewenglowski and A. Ernault.

Les Couleurs et la Photographie. 370 pages. Paris, 1895. Société d'Editions Scientifiques.

General scientific and historical summary.

1895. Otto Wiener.

Farben Photographie durch Körperfarben mechanische Farbenanpassung in der natur. Wiedemann's Annalen der Chemie und Physik, 2d vol. for 1895 (vol. 55, new series), pages 225-281.

In this monograph of 56 pages the author endeavors to throw light upon the nature of the colored images upon silver haloids as described by Seebeck, Becquerel, Poitevin, and others, and he formulates a new theory as to the way in which non-interference direct heliochromes are formed.

A first necessity was to discover a reliable means of distinguishing between interference colors in a heliochrome and body or pigmentary colors. This means was found in an observation through a right angled prism in a way elaborated by the author, and is based on a shift of the line of the color boundaries when the colors are the result of interference action.

Colors obtained by the method of Becquerel on a chlorinized silver plate proved to be in the main due to interference, rather than to a pigmentary coloring, but when chloride of silver in a flocculent mass was used, as in Seebeck's experiments, the coloration was pigmentary in its nature. Such pigmentary effects show the same color whether viewed by reflected light or transmitted light. As bearing on such effects as can be obtained without the reflecting surface (silver plate), it proves, as might be expected, that in Becquerel's method pigmentary color is produced to a certain extent, although the effect is in the main due to interference.

The clew to a right understanding of the formation of pigmentary products in the case of the Seebeck effect is to be found in the researches of Carey Lea on the colored haloids or sub-haloids of silver. The material in the plate forms colored compounds under the various spectral rays; but up to the present time there has been no explanation why the colored compound corresponds to the rays which produce it.

The view of the author is that under the action of light there is a potentiality of producing the various colored bodies (query sub-haloids of silver), and indeed there is always a general production of these various colored bodies. Any given color tends to survive under radiations corresponding to itself, because it itself best reflects that radiation, absorbing it least and, therefore, being least affected by it.

As an illustration of this action one spectrum was thrown across another, and it was seen that each color tends to destroy tints other than its own.

Wiener sets it down as a probable general law that colored illumination acting on suitable material generates pigmentary bodies of corresponding color.

The color adaptability of caterpillars and other forms of life probably depends upon the presence of some color sensitive substance, and the survival of the product corresponding in tint to the surroundings.

1896. Macfarlane Anderson.

Photogram, September, 1896, page 227.

An article bearing on the ruled color screen method. It is stated that Anderson anticipated some of the recent introducers of the method.

1896. I. W. Bennetto.

Photogram, November, 1896, page 273.

A summary of various opinions on the results obtained by Mr. Bennetto is to be found in the above.

1896. Captain Colson.

Photography for July 23, 1896, describes a method by Captain Colson in which prints obtained from colored glasses on what is termed celloidin paper are fixed by being kept in contact with a sheet of blotting paper impregnated with ink containing gallate of iron.

1896. F. W. Lanchester.

Amateur Photographer, October 16, 1896, page 318.

Mr. Lanchester interposes a grating, with spaces less than the bars, between the lens and the object, and a dispersing prism is adjusted at any convenient position between this grating and the sensitive plate. Each gap in the grid now gives a short but extremely broad spectrum and these spectra become a many tinted equivalent of the three-colored screen. The reconstitution of the colors to the eye might be possible with some similar spectral device or a colored screen.

1896. Lieut.-Col. St. Florent.

Bulletin de la Société Française de Photographie, May 15, 1896, page 252, and June 12, 1896, page 287.

Celloidine paper (collodio-chloride paper, presumably) is tinted by light, restored by a bath containing iodine and exposed under a colored original, then fixed in a 6 per cent. hyposulphite of soda bath. The colors produced by exposure disappear in the fixing bath, and it is essential that they should completely disappear. The print is washed and dried, then exposed to the sun or to a gentle heat, when the colors reappear; but yellows are almost always rendered as red.

1896. E. J. Wall.

Notes on Three-Color Printing. Photographic Journal, January 31, 1896, page 100.

1896. C. L. Bothamley.

An account in Photography, June 4, 1896, of the applications of the diazotype process to produce three colors on a single surface. Processes stated to be the invention of Lumiere and Segewitz.

1897. J. A. C. Branfil.

British Journal of Photography, February 26, 1897, page 142.

A suggestion based on the method of three-color heliochromy on one plate under a screen plotted out in lines (or other pattern) in three colors. Mr. Branfil proposes that, in taking the original negative, a diaphragm should be used having four perforations, three of these being covered with a red, green, and blue-violet window respectively, and the fourth being left uncovered. A ruled screen must be so adjusted in front of the plate as to cast pinhole images of the diaphragm apertures, and a suitable screen must be used in making three-color printing surfaces and a key from the negative.

1897. A. Graby.

Photogram, February, 1897, page 38. Translation in abstract of paper from Comptes Rendus, "In Natural Colors."

A method of heliochromy on a single surface of silver chloride, exposure being made in contact with various reagents. It appears to be assumed that red, blue, and yellow subchlorides of silver are actually or potentially in the film before the exposure to the colored image, and the abstractor says:

"Under the influence of blue light, the blue subchloride is not sensitive, and remains the same; but the red, if mercuric chloride be present, takes up chlorine and is converted into the blue. If chromic acid be present also, the yellow becomes oxidized to blue, so that only blue remains.

"Under yellow light the chromic acid is not affected, but the blue and red—especially the former—are bleached, losing their chlorine and amalgamating with mercury.

"Under red light the red subchloride remains unchanged, but the blue is changed by the red orange rays into the red subchloride.

"White light produces blue or greenish yellow, according to whether the paper is exposed in the dry or moist condition."

The method appears to be one of a kind which accords generally with Wiener's theory.

1897. Louis Ducos du Hauron.

Photogram, March, 1897, page 86. Portrait and biographical notice by his brother Alcide Ducos du Hauron.

It is stated that Du Hauron's first results were exhibited before the Photographic Society of France, on May 7, 1869, and many persons believed the specimens to be fraudulent. It is not stated whether these results were by that form of the three-color method in which three separate negatives are used, or that in which a single plate is exposed behind a three-colored screen. Both methods are explained in Louis Ducos du Hauron's book, published by Marion in 1869.

1897. Leon Vidal.

Photographie des Couleurs, 92 pages, Paris, 1897, Gauthier-Villars et Fils.

Treats principally of three-color heliochromy.

1897. H. Watzek.

Amateur Photographer, February 26, 1897, page 164.

Application of the three-color process of heliochromy to direct "carbon" or gum-aquatint printing.

1897. Sir Henry Trueman Wood.

Photography in Colors (letter). Journal of the Society of Arts, January 29, 1897, page 158. The Times, January 30, 1897.

Production of Color by Photographic Methods.

Paper read February 24. Journal of the Society of Arts, February 26, 1897, page 278.

A general study of the problem and summary of progress to the present time. Statement as to the Dansac-Chassagne process as far as it had been made public.

1897. Alcide Ducos du Hauron.

"La Triplice Photographique des Couleurs et l'Imprimerie," Paris, Gauthier-Villars (488 pages).

A full account of the researches of his brother Louis, and his method of three-color printing. Descriptions are given of several devices for producing color by three negatives and three colored glasses, by a triple-color line screen, etc. (For extracts relating to early work see 1859.)—Journal of the Society of Arts.

TOURNAMENT OF AUSTRIAN HUSSARS.

The Emperor of Germany, during his recent stay at Vienna, after breakfasting with the officers of his Austrian regiment, the Seventh Hussars, witnessed a display of horsemanship by the men of that regiment. The windows looking on the quadrangle of the barracks were filled with spectators. On a little pavilion in the midst of the public, the Emperor took his stand, to his right the colonel, to his left Archduke Otto, in the background his suite. With unsurpassed dash two officers and fifty-eight hussars rode a richly figured maze. The elegance and precision with which the soldiers executed the complicated movements at a rapid pace gave a brilliant testimony of their perfect horsemanship.

The Emperor's attention was no less attracted by an assault at arms with simultaneous taking of obstacles, which seventy-two hussars went through. Hot conflicts of highly dramatic character ensued. To guard the combatants from the deadly blow of the sword and the lance, wielded with full force as in earnest warfare, a wire mask protected the head, giving the warriors a grotesque aspect, as they mastered their chafing steeds with an incredible agility. Emperor William was so pleased with the maneuvers that he bestowed a medal on the captain, Baron von Klingspor.—Illustrirte Zeitung.

THE MONT BLANC OBSERVATORY.

The name of Joseph Vallot is at present one of the best known in alpinism and in the meteorology of high altitudes. It is a matter of common knowledge that, nearly at the summit of Mont Blanc, he has established a station for observations, that is to say, what is called the "Vallot Observatory," although by right of priority it should be styled the Mont Blanc Observatory. This is his personal work. It was he who conceived the first idea of it, and who established it with his private fortune, being assisted only by the advice and architectural knowledge of M. Henri Vallot, a member of his family.

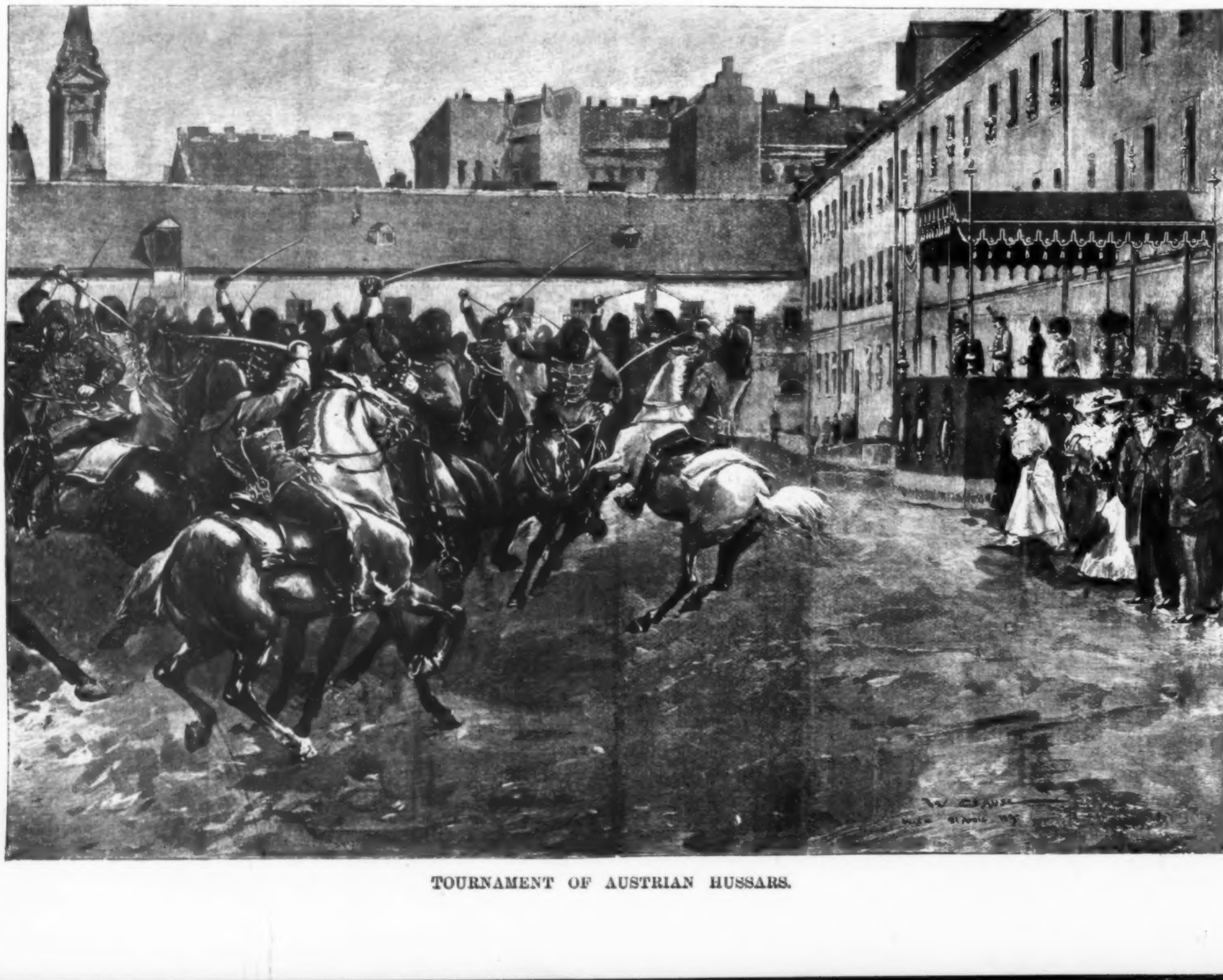
The matter assumes still greater interest when we observe what the modest station of two rooms built upon the rock of the Bosses has now become. Even this small station doubtless necessitated considerable effort, a great expense, and trouble to construct what was so much the greater in that the founder and laborers had to remain under a tent exposed to the inclemency of the weather, but when one enters the present observatory of Mont Blanc, and sees the arrangement of it, he is amazed. It is a genuine house situated at an altitude of 14,360 feet, and, at the same time, a wonderfully well equipped scientific station. The photographs that we reproduce, and that are due to M. Vallot himself, give a suggestive idea of this installation, in which the

Fig. 1.—EXTERNAL VIEW OF THE VALLOT OBSERVATORY UPON MONT BLANC.

kitchen leaves nothing more to be desired than does the laboratory.

We shall not recall here the details of the construction of the laboratory in 1890, as these were spoken of at the time. The cottage, the execution of which was brought to a successful issue by three guides, was $16\frac{1}{2}$ feet in length by 10 in width, and was divided into two rooms, one of which was offered as a refuge to travelers and the other of which formed the observatory. With these modest dimensions, it rendered the greatest service to science and scientists and to simple tourists. Thus, as long ago as 1890, the eminent astronomer Janssen stayed in the observatory for nearly a week, studied the oxygen of the sun and verified his memorable labors upon this subject.

M. Vallot, however, did not wish to stop here, and while he was occupied with the construction of the Alpine club on the Grands Mulets, enlarged his Mont Blanc observatory by four rooms, two of which were designed for tourists. In 1891 he afforded lodging therein to the expedition sent by M. Eiffel to excavate a research gallery in the rock through the snow of the summit. Finally, since 1892 the observatory has embraced no less than eight rooms, which are a great many for such an altitude, especially when we consider the comfortable arrangement and furnishing thereof. The habitability of the structure is now perfect, even during snow storms. Moreover, let us note that the foundation of the building is excellent, owing to the framework that supports it and the stanchions that have a bearing externally. A stone wall incloses the edifice and embraces the stanchions, and the ice constitutes between the stones a cement of extreme hardness. A great advantage exists in the fact that the board walls are everywhere double, and thus inclose a mattress of air that assures a good internal temperature. The room at the entrance was formerly unin habitable during storms, as the snow blew in every time the door was opened. At present a double wind-screen in front of the entrance prevents this. Finally, the windows are provided with double sashes and with internal sliding shutters. The area occupied by the building is $96\frac{3}{4}$ square feet, and the structure is, as we have said, divided into eight rooms—a kitchen and work room, forming a vestibule; a room for guides to the right, containing five beds and leading to the provision room; the director's room, with two beds on a line with the latter; then a registering apparatus laboratory and an extremely well organized room for pho-



TOURNAMENT OF AUSTRIAN HUSSARS.

tography and spectroscopy, lighted solely from above by means of a window that may be entirely closed or be fitted with a sash set with colored glass. Parallel with the last mentioned room there is a sleeping apartment, with three beds, for friends, and finally a physical laboratory in which is installed a lathe, and by way of which the kitchen may be reached. These rooms are ten feet in length, and, although the roof of those at the extremities has a somewhat steep pitch, living therein is comfortable, despite the altitude of the place and the surrounding snow. If one takes a glance at the principal laboratory, he will be astonished not only at its arrangement, but also at the innumerable instruments that it contains. The fact is that M. Vallot has spent no less than $4,000 in the purchase of apparatus. The kitchen utensils did not cost so much, but they are none the less appreciated by the dwellers in the observatory, and represent a respectable arsenal. In the photograph of this kitchen we shall point out the two kerosene stoves, because the kettle that they support is of a peculiar type. Since water boils at 85° at this altitude, it has been necessary to devise a sort of digester for cooking the food.

FIG. 2.—PRINCIPAL LABORATORY OF THE OBSERVATORY.

FIG. 3.—DIRECTOR'S ROOM.

FIG. 4.—KITCHEN OF THE OBSERVATORY.

We cannot attempt to show the ingenuity that has been expended on this installation by M. Vallot, aided by the experience of his relative. The reader will, however, readily conceive what trouble and expense the carriage of loads exceeding a weight of 30 pounds from Chamonix to the rock of the Bosses involved. Let us add that M. Vallot, while reserving the main building for an observatory, constructed and then gave to the commune of Chamonix a refuge consisting of two rooms for travelers.

It is now seven years that the Mont Blanc Observatory has been in operation. The director occupied himself at first with meteorology, but inasmuch as a new observatory has been built for this purpose upon the very snow of the summit, he now devotes himself to the physics of the globe, and those who desire to be informed as to the mass of work that he has been able to accumulate will merely have to read the two fine volumes that he has already published under the title of Annales de l'Observatoire Meteorologique du Mont Blanc. One will see therein how much science is indebted to this modest savant, who has not hesitated to devote $13,000 of his private fortune to so bold an undertaking.—La Nature.

STATISTICS OF THE COINAGE OF FRANCE.

WHEN France concluded the monetary convention of the Latin Union with Belgium, Greece, Italy and Switzerland in 1885, she pledged herself to centralize and to communicate to her associates all the administrative and statistic documents relating to the putting in circulation of coin, to the production and consumption of the precious metals, to the circulation of money, and to the counterfeiting and alteration of coin.

This was pledging herself to prepare, if not to write, a history of gold and silver coin.

M. De Foville, director of the mint, has just published the first chapter of such history in the form of a report addressed to the Minister of Finance, and gives us therein a number of curious details that our readers will thank us for making known to them, at least in part.

We shall say to them in the first place that the industrial activity of our mint has never before been so great. This establishment, which in 1880 limited itself to the production of 2,500,000 small coin, weighing 44,000 pounds and of the value of 200,000 francs, manufactured, in 1895, 54,300,000 coin weighing 772,860 pounds and having the value of 158 million francs. Last year (1896) these figures were largely exceeded, and there were struck 62,524,483 pieces, worth 239,927,260·61 francs.

The reason of this is that the mint does not work solely for France, but is a supplier of a large portion of the other nations of the globe, which find that she does fine work at low prices. Let us salute this national monopoly—the only one that remains to us!

In 1895, our customers, aside from Indo-China, Reunion and Tunis, were Chile, Ethiopia, Morocco, the principality of Monaco and the empire of Russia. Russia's order alone figured in the total for fifty-six and a half million francs. The execution of this order is being pursued without relaxation, and is far from being completed. The Indo-Chinese cent is the work of the engraver Dupuis, from whom was ordered the new model of our future bronze sous. This artist has sent in his design, and it is probable that before the end of the year the decimes in question will begin to circulate.

As regards the Indo-Chinese cent, it will be remarked that it is perforated in the center in order to respond to local usages, the Tonquinese pocketbook being usually replaced by a string. This arrangement has been the cause of many miscalculations in the manufacture. The edges of the aperture that it is necessary to drill in advance crush during the striking of the piece, and the result is that in case base coin of nickel were finally adopted by us, the project for drilled pieces would be resolutely rejected.

The mint, while applying itself to the production of all these beautiful coins, is also busy melting up such of our own coin as too long a use has put out of service. Apropos of this, it has made some quite curious and unexpected discoveries as to the normal and progressive wear of the louis d'or. It is found that this coin loses a thousandth of its weight every ten years, so that as the allowance for wear is seven-thousandths, it no longer represents its nominal value at the end of seventy years, and must go to the Quay Conti to take a bath.

Up to the present, such rejuvenation has not been very costly to us, but it will be entirely otherwise when the enormous quantity of gold struck between 1850 and 1860 reaches the term of its senility. This period corresponds to the influx of metal from California, during the epoch at which five hundred millions were annually struck. It is already foreseen that the recoinage, which costs at present but a hundred thousand francs at every budget, will, between 1900 and 1930, necessitate an expense of from one and a half to two millions. The time is remote, but is sure to come.

Silver coin, the production of which has known no such subsultus, will be submitted to an overhauling that is more regular, but still more necessary. Coins circulate so much the more widely, and consequently wear so much the more quickly, in proportion as their value is less.

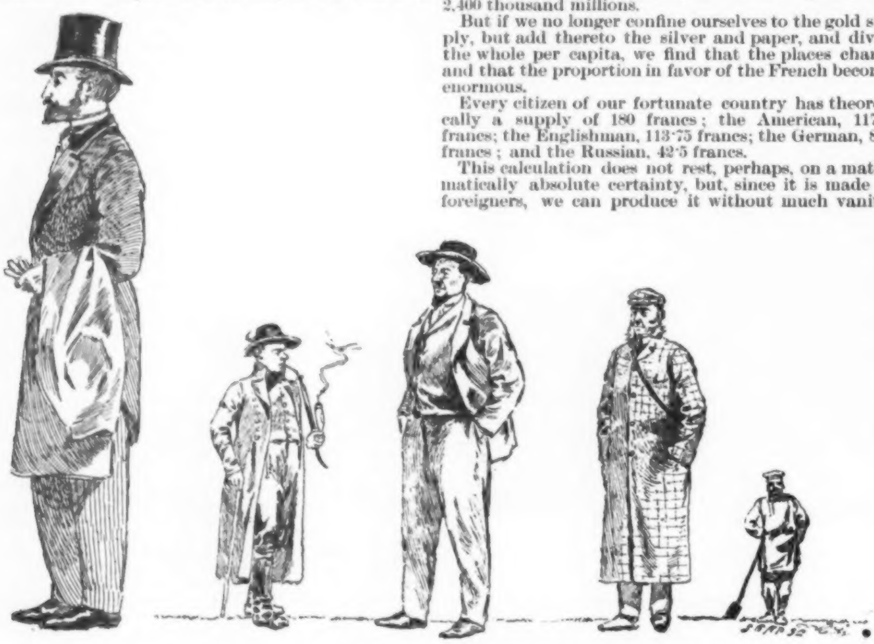
In the decimal small coin it is necessary to calculate not only upon a loss of weight, but upon the wearing away of the image. What becomes every fifteen years of the faces of sovereigns manipulated by their subjects? At the end of half a century, the effigy of a forty sous piece is still slightly visible, but before this epoch a ten sous piece is no longer anything except a white counter.

We have said that in ten years (from 1850 to 1860) more than five thousand millions of French gold were coined. This leads us to examine the question as to the total amount of the French coinage from the origin of the monetary units in use, that is to say, from 1803

for gold, the year IV for silver, and 1852 for bronze. It figures up 14,190 thousand millions, of which 8,871 millions were gold and 5,253 millions were silver.

"Of course," says Mr. De Foville, "of these 14 thousand millions, only a part is in existence. The pieces that have been melted up, destroyed, lost or exported for good certainly represent more than half of the total of the silver and perhaps nearly half of the gold. The exportation is often merely temporary. It has, moreover, as an offset, the circulation in France of many Belgian, Greek, Swiss, Italian and other coins.

"I should estimate the monetary stock of the country in French and foreign coin at two and a half thousand



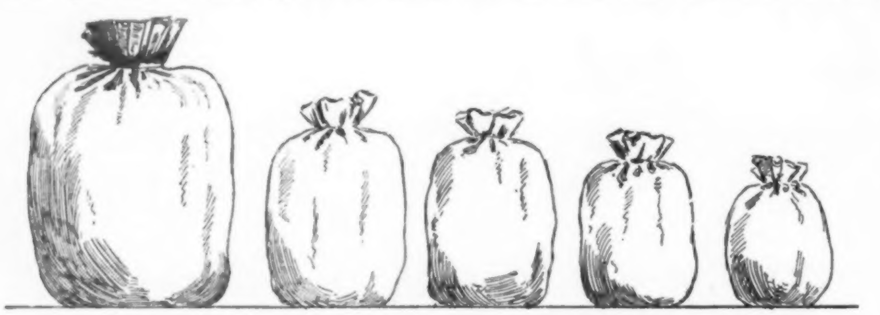
FORTUNE OF FIVE COUNTRIES BY ORDER OF STATURE.

millions, at the most, for silver. As regards gold, the figure of four thousand millions that has been suggested appears to me a minimum. The Bank of France alone has succeeded in accumulating a cash balance of more than two thousand millions."

We thus have, it would seem, six and a half thousand millions in our pocket books. This is nice, but what has become of the eight other thousand millions? We confess that this disappearance sets us thinking.

Another table tells us that jewelers and goldsmiths use 39,600 pounds of pure gold and 380,000 of silver a year, say a value of a hundred millions annually, which in twenty-four years would well account for our missing eight thousand millions; but wait a bit. In addition to our national gold, we have that which we obtain from foreign countries with a regularity that ceased only during the two years that followed the Franco-German war. From 1815 to 1895, the customs statistics give the following figures. There left our frontiers 18,619 thousand millions and there entered 29,668 thousand millions. The net importation therefore sums up in our favor by more than eleven thousand millions. Well, where are these eleven thousand millions? If we have a cash balance of six and a half thousand millions, what has it been possible to do with the rest? How heedless we are!

This saraband of thousands of millions evaporated would demonstrate to the blindest of economists that customs and other statistics should be received with caution. Mr. De Foville agrees to this with very good grace. In order to fortify his skepticism, let us recall to him the following detail. Some time ago, the Bank of France lent the Bank of England eighty millions in gold in order to put it in a position to parry the blow threatened by the failure of the Baring Brothers. This



STOCK OF GOLD OF THE FIVE RICHEST COUNTRIES OF THE WORLD.

loan was solemnly announced in all the newspapers of the time; but despite that, it escaped the perspicacity of the customs officers. The eighty millions figured in no customs returns under the head of exportation.

However this may be, and even in sticking to our six and a half thousand millions, there is a fact that seems very certain to us and that is acknowledged by everybody, and that is that France possesses the biggest money bag in the universe in absolute value, and that if we have regard to the quota of the population, the sum at the disposal of every Frenchman is infinitely larger than that which can be commanded by any other inhabitant of the earth.

The director of the United States mint, who for a certain number of years has devoted himself to the estimating of the quantity of money—gold, silver and paper—that the different countries of the globe have at their disposal, has reached results of which our sketches give a very clear idea. We have established a scale for only the five richest nations, but the American work comprises thirty-three countries.

It appears from the above mentioned work that, considering only the stock of gold, France comes in a good first with 7,250 thousand millions (about the same estimate as made by Mr. De Foville); Germany follows, in the second rank, with 3,125 thousand millions; then come the United States with 3,090 thousand millions; then England in the fourth place with 2,900 thousand millions; and finally Russia, in the fifth place, with 2,400 thousand millions.

But if we no longer confine ourselves to the gold supply, but add thereto the silver and paper, and divide the whole per capita, we find that the places change and that the proportion in favor of the French becomes enormous.

Every citizen of our fortunate country has theoretically a supply of 180 francs; the American, 117·50 francs; the Englishman, 113·75 francs; the German, 85·5 francs; and the Russian, 42·5 francs.

This calculation does not rest, perhaps, on a mathematically absolute certainty, but, since it is made by foreigners, we can produce it without much vanity; and then it is always agreeable to know that we are one of the richest capitalists of the universe.—Le Monde Illustré.

DRUNKEN BEES.

Mr. J. Ll. Williams has a very curious note in a recent number of the Journal of Botany, on the drunken habits of certain humblebees. The intoxicant is the honey produced by the crowded flowers of the capitulate heads of certain Compositæ (Carduus nutans and lanceolatus and Centaurea scabiosa) and Dipsacaceæ (Scabiosa succisa). The intoxication is indicated by rolling on the back, striking the legs wildly in the air, and general helplessness. The bees rapidly recovered from the effects, and, in most cases, were eager to repeat the debauch; but one individual, which had been shut up in a vasculum with copious supplies of Centaurea scabiosa, manifested, the next morning, a praiseworthy remorse and disgust, "raising its head and fore legs as high as it could above the plants, then precipitately hurrying away as soon as released." The most dissolute species appears to be the neuter of Bombus lapidarius. The author suggests that this may in time become a normal mode of crosspollinating the flowers in question.

The reputation of cycles of German manufacture, says Stahl und Eisen, is improving, and the prejudice which places the French, English and American product before the German is losing ground. In January, 1897, 481 cycles and 33,200 kilos of cycle fittings were exported from Germany, and in February 672 machines and 22,300 kilos of fittings were sent abroad. One thousand one hundred and fourteen wheels were imported into Germany in the first two months of this year; the prejudice against the home make is thus still strong in Germany. Foreign competition in the cycle trade is greatly helped in Germany by the low duty rates. They amount to about 1 per cent., while in the United States they are 25 per cent., in Canada 27½ per cent., in Portugal 27 per cent., in Greece, Cape Colony and New Zealand 20 per cent., in Sweden 15 per cent., Transvaal 10 per cent. of the value of the goods. In Russia and Italy there is a charge on each cycle of $9.50 and $8.50 respectively. In France the charge is $44; in Switzerland $14 per 100 kilos. The low customs duties collected by Germany have been taken advantage of by smugglers who imported wheels intended say for Holland into Germany, and then had them ridden over the frontier by suitable agents.

SELECTED FORMULÆ.

Hectograph That Will Not Turn Rancid.—Carbolic acid is usually added to hectograph mixtures as a preservative. The following formula will be found to yield a satisfactory pad:

Gelatin	4 ounces
Glycerin	15 fl. ounces
Carbolic acid	½ "
Water	15 "

Add the water to the gelatin and allow to soak until the mass is softened. Then dissolve in the glycerin with the aid of heat; the heat should be maintained until most of the water is evaporated. The acid is added carefully before cooling sets in.—American Druggist.

Bernegan's Bedbug Soap Solution.—

Soft soap	100 grammes
Caustic soda	15 "
Water	1400 "

A similar preparation is the following, the object of the turpentine (some use resin) being to glue down the unhatched eggs:

Dieterich's Bedbug Exterminator.—

Soft soap	200 grammes
Turpentine (thick)	50 "
Kerosene	100 "
Water	650 "

Dissolve the soap in the hot water, incorporate the turpentine, then the kerosene, and stir until cold.

Hager's bedbug tincture contains colocynth, aloes, pepper, copper sulphate, alcohol and water, in which, however, the copper sulphate is superfluous.

Benzin does not kill the eggs and so may be fortified by naphthalin. The following, but for its dangerous nature, might be considered an almost ideal bug exterminator:

Naphthalin Bedbug Exterminator.—

Naphthalin	100 grammes
Benzin	900 "

This mixture may be used indiscriminately on bedding, furniture, textiles of all descriptions, wall paper, etc.

To eradicate bugs from the house all wall paper must be torn off and the partitions treated with the soap solution mentioned above; the floors must be similarly scrubbed, cracks and crevices cemented with hard soap, and if calcimined, the liquid should contain decoctions of some of the bitter substances enumerated above. In the tightly closed room sulphur may also be burned, as well as wood alcohol for the production of formaldehyde; also shallow vessels containing ammonia or formaldehyde may be set on the floor and left over night.—Western Druggist.

Cockroach Powder.—Borax is said to be the best cockroach exterminator yet discovered, and most of the powders contain it as a principal ingredient. This troublesome insect has a peculiar aversion to it, and will never return where it has once been scattered. As the salt is perfectly harmless to human beings, it is much to be preferred for this purpose to poisonous substances.

Barium nitrate or carbonate combined with sugar is recommended by some.

A mixture of 100 parts powdered angelica root and 20 parts oil of eucalyptus has also been recommended. This, however, would be too expensive for general use.

The Standard Formulary gives the following formulas for roach powders, which undoubtedly will prove satisfactory:

(1.)	Wheat flour	4 ounces
	Sugar, powdered	8 "
	Borax, powdered	2 "
	Unslaked lime, powdered	2 "

Keep dry.

This should be strewed about on paper, taking care that no liquids are left uncovered.

(2.)	Borax, powdered	12 ounces
	Starch, powdered	3 "
	Cacao, powdered	1¼ "

Mix.

(3.)	Insect powder	16 ounces
	Tartar emetic	14 "

—Bulletin of Pharmacy.

Black School Ink.—The aniline inks, as generally made, are specially fugitive. If permanence is not considered, the following, by H. Wilder, serves well enough for a cheap school ink, etc.:

Methyl violet	6 grammes
Bengal green	10 "
Bismarck brown	4 "
Acacia	60 "
Water	8 fl. oz.

Three Chlorids Embalming Solution.—

H. R. Tilton, surgeon U. S. army, gives the following formula for an embalming solution:

Sol. zinc chlorid (U. S. P.)	1 gallon
Sol. sodium chlorid (6 oz. to pint)	6 pints
Sol. mercury bichlorid (1 oz. to pint)	4 "
Alcohol	4 "
Carbolic acid (pure)	8 ounces
Glycerin	24 fl. "

Mix the glycerin and carbolic acid, then all the other ingredients, when a clear solution of 3 gallons results, which is the proper amount for a body weighing 150 pounds. This may be injected into the aorta, but it is much less trouble to inject into the brachial or femoral artery—or the femoral vein. An anatomical syringe is desirable, but a gravity apparatus that will answer all purposes may be improvised with rubber tubing, stopcock, etc. A fluid drachm is sufficient to preserve each ounce of animal weight. For human bodies it is well to calculate 2¼ fluid ounces per pound weight.

For Removing Lice from House Plants.—

Salicylic acid	1 ounce
Soft soap	2 "
Quassia	10 "
Alcohol	40 "

Make a tincture and use as a spray.

ENGINEERING NOTES.

A steel roadway for highways is to be built at the Nashville Centennial by General Roy Stone, of the Office of Road Inquiry, at Washington, D. C. A roadway 300 feet long is to be thus equipped as an object lesson.

Experiments on the bursting of small fly wheels are being conducted at a school of science in Cleveland, O. The first wheel tested was 15½ in. diameter, and burst at a speed of 6,525 revolutions per minute, or a rim speed of over five miles a minute. The wheel was driven by a steam turbine, and the speed was determined by observing the tone. A timber casing built around the wheel was entirely demolished. According to the Engineering News, one piece of the rim shot through 4 in. of pine, and 2½ in. into the hardwood floor, cutting its way like a bullet.

On December 31, 1896, there were open in Russia, says the Engineer, 25,756¼ miles of railway, of which 5,034 miles were double lines. During the year 1,525 miles were constructed, against 1,326 miles in 1895, including 1,031 miles of the Trans-Siberian Railway—the section Ekaterinberg-Tscheliabinsk-Os. In addition, government lines to the length of 3,448 miles are in course of construction. Private companies are constructing 2,488½ miles, principally between Moscow, Briansk, and Krassny on the Archangel line, and from Pstow to Bolocoe. New lines are constantly being planned and concessions regularly granted.

Fares on Belgian railways were changed considerably after May 1, according to Uhland's Wochenschrift. Hitherto a higher fare has been charged for express trains than for local or accommodation trains. Henceforth fares will be uniform except for the so-called international trains. Also, prices of third class commutation tickets and workingmen's tickets were reduced 10 per cent. To compensate for the loss, the price of second class tickets was advanced 12½ per cent. (5 per cent. of commutation) and that of first class tickets 25 per cent. (10 per cent. of commutation or season tickets).

Russia is showing herself far more broadminded than Germany in connection with the railroads about to be built in China. For whereas Germany expressed her willingness to furnish the money needed for their construction, provided the materials were made in Germany, Russia, which has undertaken the job, has announced her intention of getting the engines, the rolling stock, the rails, etc., in the best market. It is with this object in view that Privy Councilor Joguvitch, who has recently been appointed by the Czar to the post of director-general of the China railroad system, is coming to America for the purpose of making extensive purchases in the United States.

The New York Central now has a fire car placed in its yards at Buffalo. It is 34 ft. long, and carries at each end a 3,500 gallon tank. Between these tanks is a pump house, equipped with one Fairbanks & Morse duplex fire pump, with 12 by 12 in. steam cylinders, and water cylinders 8 by 12 in. The water discharge is arranged for three 2½ in. hose connections, so that three streams can be used at one time. The steam for running the pump is supplied by the locomotive used to draw the car. The car is equipped with the company's standard Sewall steam hose connection, so that any available engine can be used to operate the pump. The hose used with the car is 2½ in. lined hose, and the opening in the nozzle 1 in. There are two reels, carrying 300 ft. of extra hose, with a pressure of 80 lb. of steam, and a 1 in. nozzle, throwing through 100 ft. of hose.

Many of our readers, says the Trade Journals Review, may have had the disagreeable experience outside the Mersey bar which Sir Douglas Fox so graphically described in his presidential address before the Mechanical Science Section of the British Association. For it is not long since this sand bank was removed, and the available depth at low tide increased from 11 to 24 feet in a channel 1,500 feet in width. Those who have made the transatlantic passage before that period can readily appreciate the great advantage accruing from this improvement. Formerly vessels arriving off the port on a low tide had to wait for some hours for the water level to rise sufficiently to enable them to cross the bar. The result of a large vessel lying outside, rolling in the trough of the sea with her engines stopped, was that not infrequently this proved to be the worst part of the voyage between New York and Liverpool; and passengers who had escaped the malady of seasickness throughout the voyage were driven to their cabins and berths within three or four hours of landing. Now, owing to successful dredging operations, ships of the largest size can enter or depart from the Mersey at any state of the tide, and they are also able to run alongside the landing stage without the intervention of a tender.

The deepest bore hole in existence is said to be at Parnschowitz, near Rybrick, Upper Silesia, says the Engineer. It is 6,571 ft. below the surface of the soil, and was made in a search for coal measures. The hole was 12 in. in diameter at the beginning, and this was lined with a tube about 0·4 in. thick; at a depth of 230 ft. the bore was reduced to 8¼ in. diameter, and thus continued for 351 ft. The greatest difficulty encountered was the great weight of the boring rods as the depth increased. Though steel was used, at a depth of 6,560 ft. the total weight of the tools reached 30,155 lb. Under this weight ruptures of the rods were frequent, and an accident of this nature finally stopped the work; about 4,500 ft. of rods fell to the bottom, and, being jammed under a part of the tubing, it was impossible to withdraw it. The diameter of the well at the bottom was 2¾ in. Temperature observations made showed 12° C., or 53·6° F., at the surface, and at the depth of 6,571 ft. the temperature reached 69·3° C., or 157° F. This is equivalent to an average augmentation of heat of 1° C. for every 34·14 m. of depth, or 1° F. for every 63 ft. These figures differ slightly from those obtained in other deep borings, the increase of heat at Schladebach corresponds to 1° C. in 35·45 m.; that at Sperenberg, near Berlin, to 1° C. in 32·51 m.; and at the artesian well of Grenelle, at Paris, which is only 1,797 ft. deep, and furnishes water at a temperature of 27·70° C., it is estimated that the increase of heat is equivalent to 1° C. in 31·83 m.

ELECTRICAL NOTES.

Two new telephone cables, each with two circuits, are to be laid at once across the English Channel, thus making practically six lines for the London telephone service.

Prof. Pinto, of Rio de Janeiro, has invented a new process for preserving meat. He immerses the same in a common salt solution through which an electric current is continually passing. The electrode used must be of platinum.—Die Umschau.

It is said that as early as 1812 Baron Schilling used a cable under water for exploding mines in the Neva by means of the electric spark. For a certainty we know that Col. Pasley, in 1838, made use of that method to explode the wreck of the Royal George, in the dock at Spithead.—Uhland's Wochenschrift.

Paris and Madrid will soon be brought into telephonic communication. A telephone line between Paris and Bayonne has been decided upon, and from Biarritz to St. Sebastian the line will be extended a distance of about forty miles. St. Sebastian is already in telephonic communication with Madrid.

In Berlin the telephone authorities have decided to allow two non-subscribers to talk with one another between two pay stations. The non-subscriber who is called will be brought from his house to the nearest call office by a special messenger. The charge will be twenty-five cents for five minutes' conversation.

On April 13, at Anderson, Ind., Judge Bundy made a ruling that a conversation held over the telephone between the parties to the litigation should be admitted in evidence. Objections were raised, but the court ruled in favor of the defendant and admitted the legality of the telephone and the telephone conversation as evidence. It is said to be the first decision of its kind rendered in the United States.

On August 5, 1858, Queen Victoria telegraphed to the President of the United States that she hoped the transatlantic cable, which was opened on that day, would prove an additional link between the two nations, to which the President replied: "May the electric telegraph, under the blessing of Heaven, prove to be a bond of perpetual peace and friendship between the two great nations." This message is interesting in view of the recently proposed arbitration treaty.

The State Department, Washington, has issued a statement taken from the British Board of Trade Journal for January, 1897, showing the rates of import duty leviable on dynamo electric machinery and electric lamps in the principal European countries and India. The countries named are Austria-Hungary, Belgium, Bulgaria, Denmark, France, Germany, Greece, Holland, Italy, Norway, Portugal, Roumania, Russia, Spain, Sweden, Switzerland, Turkey, the United States and India. This is a valuable compilation, and all interested in the electrical export trade will find it to their advantage to procure a copy.

For some time, says the London Electrical Review, E. Andreoli has been engaged in investigating the behavior of primary batteries, which depend, as regards their action, upon the continuous oxidation of hydrogen, carbon monoxide, etc. Although his results have been for the most part of a negative nature, they are none the less valuable on that account, inasmuch as it is often as useful to know that a thing cannot be done as that it can. During a portion of his investigation, he has been collaborating with Borchers, and together they have fixed upon the weak point in the batteries with which they have experimented. This consists in the use of electrodes which become dissolved as the battery acts. They have both come to the conclusion that success with such batteries may only be secured by discovering and employing electrodes which do not pass into solution during the oxidation of the gas which is used in the battery; it remains, therefore, for themselves or others to discover and apply such electrodes. A full account is given of these later investigations in the Zeitschrift fur Electrochemie, Vol. III, pages 186 to 189. It is of interest to note in this connection that Dr. Jacques, whose experiments have attracted attention, has gone to Europe to pursue some further researches.

A handy summary of Barus' researches on the hardness and magnetic stability of steel will be found in the new number of Terrestrial Magnetism. His valuable definition of thermo-electric hardness, based upon the phenomenal rate at which both the resistance and the thermo-electric power of steel increases with its state of temper, deserves to be more generally known, as it enables us to define the hardness with an accuracy of 1 in 1,000. The relation between the thermo E. M. F. per degree at 0° and resistivity at 0° is linear throughout the range of variation of these qualities with hardness, and this is specially remarkable in view of the fact that the hardening of steel may increase its resistance threefold. Barus give us the following definition: The E. M. F. in microvolts per degree at 0° of a thermo element consisting of steel in the imaginary normal state whose resistivity is zero, and steel in any given state, is the thermo-electric hardness of the latter. As a result of his researches he gives some valuable hints for making highly permanent magnets. The maximum of permanent magnetization for any given temperature which can be imparted to a steel rod exhibiting the maximum of permanent hardness for the same temperature is wholly independent of previous magnetizations. Hence the following rules: Having tempered a given steel rod in such a way as insures uniformity of glass hardness throughout its length, expose it for a long time (say 20 to 30 hours, or longer in the case of massive magnets) to the annealing effect of steam at 100°. The operation, which may be interrupted as often as desirable, imparts the maximum of permanent hardness for 100°. Then magnetize the rod to saturation, and expose again to steam for about five hours. The magnet will then exhibit both the maximum of permanent magnetization as well as the maximum of permanent hardness for 100°. Its degree of magnetic permanence against effects of temperature below 100°, against time, and percussion is probably the highest conveniently attainable. Rods tempered glass hard are not to be used as essential parts of magnetic instruments.

MISCELLANEOUS NOTES.

A law has been enacted in New York making it a felony for any one except a duly licensed physician to have an anæsthetic on his person with the intention of administering it to another person. Violation of this edict will be regarded as presumptive evidence of guilt.—Med. Times.

The largest solid piece of slate known to the slate industry has been successfully blasted at Bethlehem, Pa. The block, which was moved six inches from its original bed, measured 67 feet in length, 14 feet deep and 13½ feet in width, and contained 12,663 cubic feet. It weighs 22,127,384 pounds, or nearly 1,064 tons. It will produce 1,637 squares of roofing slate, and will require one 75 horse power engine six weeks to hoist it from the quarry.

The alarming increase in the number of murders and suicides in this country is shown from the statistics recently collated as they relate to 1895 compared with preceding years. From these it appears that the number of murders (including homicide) in the United States attained last year the unprecedented figure of 10,500, as compared with 9,800 in 1894, 4,290 in 1890, and 1,808 in 1885. Hence, the increase of homicidal crime is of a most rapid and serious nature. The suicides in 1895 numbered 5,750, as compared with 4,912 in 1894, 2,040 in 1890, and 978 in 1885. The legal executions in 1895 were 132, being the same as in 1894, whereas in 1890 they were 102, and 108 in 1885. The "lynchings" or illegal executions were 171 in 1895, as compared with 194 in 1894, 127 in 1890, and 108 in 1885. Hence there was a decrease of 23 last year as compared with 1894. But both as regards legal and illegal executions in the United States there is an extraordinary difference between the ratio of increase in the two classes and the amazingly rapid development of murder of recent years. Thus, the combined legal and illegal executions for the 1,808 murders in the year 1885 were 289, nearly as many as the combined number (303) for the 10,500 murders in 1895.—Chicago Tribune.

In view of the importance of the subject it may be interesting to our readers, says The Engineer, to have the results of some experiments recently carried out by Messrs. H. F. Hunt and L. J. Steele, MM.S.C.I., with aluminum when in contact with mercury. It was found that: (1) By allowing the aluminum to stand on mercury, covered with a thick film of oxide, the aluminum does not visibly amalgamate, and the white formation occurs on almost all parts of the metal, even where not directly in contact with the mercury. (2) By keeping the aluminum beneath dirty mercury, it was found on removal that the action was far weaker than in the previous case. (3) By standing the aluminum on distilled mercury the white substance produced was so slight as to be scarcely visible, while none at all was produced by keeping the aluminum submerged under distilled mercury. (4) By amalgamating the surface of the aluminum with mercury, in the presence of either potassium cyanide or nitric or sulphuric or hydrochloric acid, or by the presence of sodium amalgam, the white concretions resulting from this amalgamated aluminum are thicker, but much more uniform in their growth, than those resulting by leaving the aluminum on a film of mercurous oxide.

When the size of a tracing exceeds a comparatively moderate limit, the cost and weight of the blue printing frame required becomes excessively great. To deal with such cases, Mr. W. Parker, the divisional engineer of the Boston and Albany Railroad, has, as we learn from the Engineering Record, adopted the plan of straining the tracing round a large cylinder, much as an indicator diagram is strained on the barrel of the indicator. The cylinder he uses is 3 ft. in diameter and 4 ft. long, and is constructed with a framing of ⅞ in. pine, lagged with hard veneer. A gap 2 in. wide extending the entire length of the shell permits of the ends of long plans being stored inside the cylinder. In printing, the cylinder is slowly rotated, being mounted on trunnions for the purpose. The largest print yet made with this device was 45 ft. long by 36 in. wide, and it was printed in five sections. As a makeshift frame for blue prints of smaller dimensions, we have successfully used a sheet of millboard. The board being laid flat and the sensitive paper placed on it, the tracing was secured in position by means of India rubber solution. When dry, which takes only a few minutes, the sheet was strained by bending up the millboard so as to stretch the tracing, and it was then kept in this position by means of a couple of slings of twine. The only difficulty met with lay in the fact that it was not possible to examine the print before completion.

It is seldom that the War Department publications enter the field of humor, intentionally or otherwise, says a correspondent of the Army and Navy Journal, but at least one paragraph of "Document No. 18" involves a statement of fact, made in all gravity, that might well make a believer in heredity infer that the son of John Phœnix was an officer in the Subsistence Department, instead of the Engineers, and in that capacity edited the new "Manual for Army Cooks." On page 191 thereof there appears this sapient statement: "The presence of wormholes in coffee should not occasion its rejection, unless it is of inferior quality and strength, since they generally indicate age, weigh nothing and disappear when the coffee is ground."

Among the many services done to the Turks by Greece in the last few weeks not the least is to have given them an opportunity of showing how and what they can endure. The Times correspondent is much struck with their eagerness to fight and with the difficulty of killing them. He mentions one man whose abdomen was penetrated by a bullet, and who not only kept his place in the ranks till the battle ended, but marched ten miles afterward. Another man with three wounds—two in the legs and one in the shoulder—continued on duty twenty-four hours, until an officer noticed his condition and sent him to hospital. Sometimes our alcoholism has been associated with our daring and our endurance as cause and effect, but here are qualities of the same sort in a non-alcoholic nation. Our contemporary's correspondent remarks further on the rapidity with which wounds heal, and says that medical men attribute it to the abstemiousness of the Turks. Here we should scarcely be able to match the race whose soldiers are ill clad, ill fed, and who take no alcoholic stimulants, says the Lancet.

ON CHARGING OPEN HEARTH FURNACES BY MACHINERY.*

By Mr. JEREMIAH HEAD, M. Inst. C.E., Past President of the Institution of Mechanical Engineers.

THE gradual development during the last twenty-five years of the open hearth process for the manufacture of steel, and the severe competition which has since arisen between different districts and countries, has compelled more and more attention to be paid to all expedients which promise to save labor, time, and other elements of cost.

Materials Charged.—Confining our attention for the moment to the acid process, which is that by which open hearth steel is at present usually made in this country, we find that for every ton of steel produced in the shape of ingots, the following quantities of materials are introduced into the furnace:

	Cwt.	Percentage of Charge.
Hematite pig iron	16	66·7
Wrought scrap	4	16·7
Ore (containing 50 per cent. Fe)	4	16·6
Total	24	100·0

The 20 cwt. of pig iron and scrap lose by oxidation about 10 per cent. or 2 cwt. But the 4 cwt. of ore, containing as it does 2 cwt. of metallic iron, just replaces this loss, as it becomes reduced by the action of the metalloids associated with the pig.

Acid and Basic.—The ratio of iron-containing materials charged to the steel produced does not seem to differ materially, even though the relative proportions of pig, scrap, and ore may vary considerably.

The following table gives the average practice over the year 1896 at a works in America where there are several 15 ton furnaces, with both acid and basic linings. Basic additions and ferro-manganese are in no case included:

	Acid Furnaces.		Basic Furnaces.	
	Weight Charged per Ton of Ingots	Per Cent. of Charge.	Weight Charged per Ton of Ingots	Per Cent. of Charge.
	cwt.		cwt.	
Pig iron	6	27	11¾	51
Scrap	15¼	67	10½	45
Ore	1½	6	1	4
Total	22¾	100	23¼	100

For the purposes of this paper I will assume that 24 cwt. of material must be introduced into the furnace, whether acid or basic, for every ton of ingots produced.

Capacity of Furnaces.—The capacity of modern open hearth furnaces varies considerably. The tendency hitherto has been toward continual increase. Typical steel works in the North of England have 30 ton, 40 ton, and 50 ton furnaces. Forty ton furnaces may be taken as a fair average for a modern plant.

Such furnaces when in full working order make nine heats per week of 141 hours, that is from say 6 P. M. on Sunday night to say 3 P. M. on the Saturday following. This gives $\frac{141}{9} = 15\frac{2}{3}$ hours for each heat, including fettling and charging. The full weekly produce of such a furnace would be $40 \times 9 = 360$ tons of ingots. But furnaces cannot be relied on to work fully or continuously. There are various contingencies, but too well known to managers, which prevent this.

The actual production of an open hearth plant varies from seven-eighths to three-quarters of its nominal capacity, and indeed is sometimes even less than that. Or, put in another way, from one-eighth to one-fourth of the furnaces comprised in any steel melting plant are on the average always standing for repairs.

A 40 ton furnace in fair working order requires every 15⅔ hours 40 tons × 1·2 tons (or 24 cwt.) = 48 tons of materials to be charged into it, and this occupies under present circumstances (in addition to an hour for fettling) about 3½ hours, which is equivalent to $\frac{48}{3·5} = 13·7$ tons per hour.† To perform this, among other duties, three men are employed (on each shift), called the first, second, and third hands, and these three men employ a fourth to aid them in dealing with a furnace of the size mentioned. The total number of men employed on both shifts is thus eight per furnace.

Picked Men Required.—It is clear, therefore, that each of these four men handles on the average $\frac{13·7}{4} = 3·4$ tons per hour for 3½ hours, or about 12 tons in all, each charging shift he is at work, which is alternately four or five times per week. To some furnaces light swing cranes are attached, but these are only or mainly used for heavy castings, cobbles, and so forth. The pig, scrap, and ore has to be charged by hand, and that in face of a furnace radiating a considerable amount of heat. It is evident that to fulfill these requirements great physical and constitutional strength is necessary in all the men, besides technical skill, which, however, is exercised mainly by the first hand. They must therefore be picked men, and must be paid accordingly.

Cost for Labor.—In this country the labor needed for open hearth steel melting is paid by a tonnage rate on the ingots produced. The present rate is 1s. 10½d. per ton net. In a 40 ton furnace this amounts to:

£ s. d.		£ s. d.	
0 1 10½	× 40 tons =	3 15 0	per full heat.
3 15 0	× 9 heats =	33 15 0	per full week.
33 15 0 / 8 men	=	4 4 4½	the average earned per man per full week.

* Paper read before the Iron and Steel Institute, England.

† A 40 ton furnace can be charged by hand in 3½ hours only by having two doors on the tapping side as well as three on the platform side. This is now customary in the North of England.

The average earnings per man taken over the whole year are, however, less than this by one-eighth to one-quarter, as before explained.

These labor costs, which apply to the charging platform only, do not seem unreasonable under the conditions I have described.

Saving of Time and Labor.—It is to reduce the time required to charge a furnace, and to prevent the necessity of so much and such costly hand labor, that charging machinery has been devised and brought to great perfection during the last few years in the United States. To this machinery I now propose to invite your attention.

Original Charging Machine.—Fig. 1 shows the first charging machine for open hearth furnaces ever made. It was designed and erected just ten years ago at the works of the Otis Steel Company, of Cleveland, O., by Mr. S. T. Wellman, then superintendent of the works, and is still in operation there.

It consists of a main carriage on four wheels, traveling longitudinally on overhead girders along and above the charging platform. On the carriage, and moving transversely to it, is a truck called the charger truck, having four wheels above and four below the cross girders of the main carriage. To the truck is attached an inverted hydraulic cylinder with piston and rod, to the crosshead of which a horizontal platform is fixed. The crosshead is guided by wheels traveling on strong guides depending from the carriage. As the piston is raised or lowered, so is the platform. The machineman or operator sits at the back end of the platform facing the furnace with his handles conveniently placed in front of him. The crosshead has in it a large horizontal hole at right angles to the furnace front, and through this passes a strong horizontal bar called the charging bar, which can be rotated or twisted by another inverted hydraulic cylinder on the platform acting on a rack and spurwheel. The longitudinal motion of the main carriage is effected by a fixed steam winch at the end of the charging platform. The charger truck, carrying with it the operator's platform and charging bar, is moved toward or from the furnace door by two horizontal cylinders fixed to the main carriage.

The materials are brought up to the charging platform on bogies, called charging bogies, running on a subsidiary 2 ft. gage railway, which connects it with the stock heaps and with the full gage input sidings, and constitutes a complete system, with miniature locomotives, turntables, hydraulic lifts, and so forth. Placed upon and across each charging bogie are three or more charging boxes (or scoops) into which is loaded, at the stock heaps or input sidings, the pig iron (each pig being broken in two pieces), the scrap and the ore. Each box contains approximately a ton of material.

The ends of the boxes, which, on arrival at the charging platform, are next to the machine, are steel castings formed into sockets. The end of the charging bar, which is made to fit, is brought over and dropped successively into these, and (in the original machine) temporarily secured by a wedge shaped key driven in by a boy. The operator is then able, by means of the lifting, cross traversing, and twisting cylinders, to introduce the box and its charge into the furnace, empty and withdraw it, and return it to the bogie; and the boy having knocked out the key, he repeats the process with the next one.

Defects of Original Machine.—Although this machine has worked fairly well from the first, and has effected a considerable saving compared with charging by hand, it is evidently far from perfect. The hydraulic movements are too slow, and there is loss of power when they take place with less than maximum resistance. The boy needed to fix the boxes, and the isolated steam winch, with its attendant, ought clearly to be dispensed with. The constant supply of high pressure water to a machine traveling longitudinally over a considerable distance is attended with difficulty, and India rubber pressure pipe, if used near hot furnaces, is difficult and costly to maintain. It is further evident to the eye of a mechanic that the original charging machine is deficient in strength and rigidity, and is suitable only for very light loads.

The Thurlow Machine.—For the reasons given, machinery for charging open hearth furnaces attained but limited success, until at length electricity became available as a motive power. In May, 1894, Mr. Wellman constructed at Thurlow, Pennsylvania, a charging machine in which all the movements were electrical, except locking the charging bar to the boxes. This apparatus traveled longitudinally on rails at the floor level. The floor of the main carriage was divided into three oblong sections, the two outer ones being fixed, and the center one sliding toward and from the furnace. This section carried the charging bar, the motor and gear for sliding it, the motor and gear for twisting it, and the hand gear for locking it to the charging boxes. The motors and gear for giving longitudinal movement to the main carriage and for raising or lowering the front end of the sliding section were placed on the left side fixed section, while the operator with the rheostats and current controllers sat on the right side fixed section.

Defects of the Thurlow Machine.—The apparatus was perfectly successful so far as its performance was concerned, but it had certain obvious defects. For instance, the main frame covered a floor width of 19 ft. instead of 14 ft., which alone is necessary in the latest design. The weight of the operator and his platform with the controlling gear were not utilized to counterbalance the charging box and its load. The operator was not immediately behind and opposite to the charging door, and therefore could not always see what he was doing. And, lastly, the main carriage and its fittings were not massive enough to form a sufficient base for carrying heavy loads in the boxes when the charging bar was at its farthest forward position.

The Newest Type of Electric Machine.—These defects have now all been remedied. Figs. 2, 3 and 4 (and also the model upon the table) represent a machine of the newest type, which has just been made by Mr. Wellman for the Otis Steel Company, so that that company now possesses the most recent as well as the oldest and two intermediate examples of charging machines.

Fig. 2 shows a cross section of a furnace, the charging bogie, with a charging box upon it and the charging machine itself.

Fig. 3 shows the same in plan and Fig. 4 in back elevation.

It will be seen that the apparatus has much in common with those which preceded it. It is, however, more substantial, while at the same time it is simpler and more compact. The main carriage is 5 ft. narrower from back to front than in the case of the Thurlow machine, which is a great advantage, in that less floor room needs to be kept clear. Stability is maintained by extending it 3 ft. longitudinally, an addition which interferes with nothing. At the four corners of the main carriage, box columns are erected which are surmounted by a framework consisting in the main of a pair of channel section beams fixed transversely to the columns, and projecting forward beyond the main carriage, almost as far as the furnace front. The channel beams carry rails on which runs on four wheels the charger truck. Above the wheels on either side are steel angles which serve the purpose of guard rails in case the truck should tip up behind.

Downward from the charger truck projects a strong bracket, ending in double-eye bearings, which carry a trunnion sleeve. Into this sleeve is threaded and secured with a back collar the charging bar. On the after end of the latter is carried the operator's platform, the tail end of which is connected by two rods with the pins of two cranks, keyed symmetrically to a shaft running across the charger truck frame at its rear end.

A motor carried on the truck is connected by gear with this shaft. By switching on the current the operator can rotate the crankshaft in either direction, and so move the charging bar up or down like a heavy gun in its trunnion bearings. As the motion is of the "all-round" type, no harm can come from overrunning. On the charger truck is also mounted a motor and gear for moving it and the charging bar, and all connected therewith, toward or from the furnace by operating on the front axle and wheels.

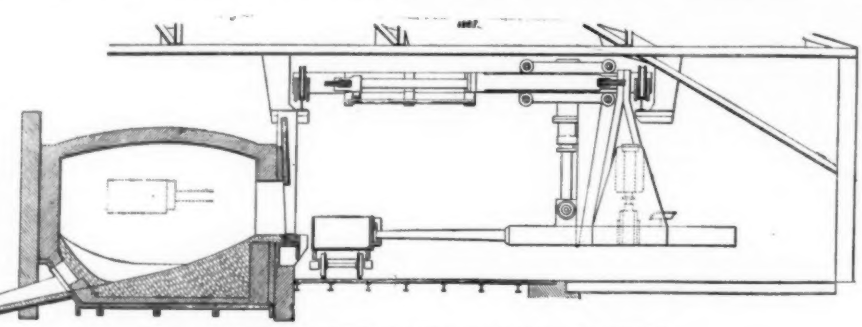


FIG. 1.—FIRST OPEN HEARTH CHARGING MACHINE.

Locking Gear.—In the most recent machines the rather complicated method adopted in the Thurlow example for locking the charging bar to the boxes has been superseded by a very simple device. The charging bar is hollow throughout its length, and the interior is occupied by a steel rod connected with a lever on the operator's platform. When the front end of the charging bar has been lowered into the socket of the box, the operator, in order to lock them together, pushes forward the locking bar by means of the lever, until the front end projects into a recess provided for that purpose in the socket of the box. A reversal of the process releases the box. The front portion of the charging bar is separate from but keyed to the back portion, so as to facilitate renewal in case of wear or accident.

The motor and gear for moving the machine longitudinally are upon the main carriage, and, as in the case of the charger truck, act on one axle only. The motor and gear for twisting the charging bar is upon the operator's platform, as are also the controllers and switches for all the motors. The accumulation of these weights in that position balances to some extent the weights lifted by the charging bar. It will be noticed that in this machine, as in the original one at the Otis Steel Works, the operator is always opposite to his work, and moves to and from the furnace with the charging bar and box. He is therefore able to see into the interior of the furnace when depositing materials therein, and at other times remain in a cool place.

Electric Arrangements.—The motors for producing the requisite movements are each 25 horse power, except that on the operator's platform for twisting the charging bar, which is only 3½ horse power. But as the maximum effort is seldom required in any of the movements, and as they are successive and not concurrent, 25 horse power may be considered the maximum used by them all at any one time. The power continuously used does not in all probability exceed an average of 10 horse power while the machine is at work. The electric current is brought from the central generating station, a department with which large steel works in the States are now almost always provided. The current, which is brought by a single pair of conductors running overhead along the charg-

ing platform, is conveyed to the operator's platform by sliding contacts, to be there distributed to the various motors. The new high framed machine has a great advantage over the old low framed ones, in that it admits of the necessarily bare conductors and contacts being kept high up and well out of the way of the traffic on the floor. The power at the central station may and should be generated by economical engines under favorable conditions. Little pressure is lost in transit, and no current is taken by the machine except when at work, and then only in proportion to the work actually done. The motors are of a simple type, incased in iron, like those so common in America for use under electric street cars. The current is a continuous one, and the voltage used is 220 to 250.

Forty-eight Tons Charged in an Hour.—The charging boxes are 6 ft. long by 2 ft. broad and 1¾ ft. deep, which gives a capacity of 21 cubic feet. This is sufficient to contain a ton of ore or scrap and more than a ton of pig iron. Except when heavy castings and cobbles are to be dealt with, a ton is a convenient average load for a charging box, and 3 or 4 tons for a charging bogie, according to whether it is made to carry three or four boxes. If the boxes are properly loaded, the machine will pick up and empty one every minute, which is equivalent to dealing with an entire charge of 48 tons in 48 minutes. Allowing 12 minutes for contingencies, a charge would occupy one hour instead of 3½ hours, which is an ordinary time required for charging a 40 ton furnace, exclusive, say, of one hour for fettling. This would be required in either case.

Thus a saving of 2½ hours per charge is effected by the machine.

Output Increased 11 Per Cent.—The time gained per week by using machine against hand labor may be expected to be at least 2½ hours × 9 heats = 22½ hours, which is more than sufficient for an extra heat, or an increase in the total output of one-ninth, or 11 per cent.

Labor Saving.—The saving to be effected by using electrical charging machinery is not one of time only. I have shown that at present eight picked men (2 shifts) are employed (in British steel works) at each 40 ton furnace, and that these men handle among them 48 tons × 9 heats = 432 tons of material every full week, the handling being done in 9 heats × 3½ hours = 31½ hours. This is equal to $\frac{432 \text{ tons}}{31{\cdot}5 \text{ hours}} = 13{\cdot}7$ tons per hour while charging, or $\frac{13{\cdot}7 \text{ hours}}{4 \text{ men}} = 3{\cdot}4$ tons per hour per man for a period of $3{\cdot}4 \times \frac{9 \text{ heats}}{2 \text{ shifts}} = 15{\cdot}3$ hours per week.

Now where the machine is employed the whole of this heavy labor is done by it, and the material need never be touched by the men at all, unless something goes wrong, or unless it be necessary at any time to adjust the position of any portion of the charge in the furnace. It is clear, therefore, that the machine is a labor saving as well as a time saving appliance.

Economies Effected in America.—Below I give an estimate made from information supplied by Mr. Wellman of the saving in cost of labor by the use of machine charging as against hand charging in two 20 to 30 ton furnaces in the United States. It will be seen therefrom that in that country, even when working with fewer and smaller furnaces than we are accustomed to here, they are able to reduce the number of men required by one-half, and the weekly labor cost to the same extent.

ESTIMATE OF SAVING OF LABOR BY THE USE IN THE UNITED STATES OF MACHINE OVER HAND CHARGING.

Cost of Labor in Operating by Hand Two 20 to 30 Ton Furnaces.

1 melter, wages per week	$30.00	
2 first helpers (22½ cents per hour each)	32.40	
2 second helpers (15 cents per hour each)	21.60	
6 stokers (13½ cents per hour each)	58.32	
1 door boy	5.40	
12 Cost of labor in one week, single turn	147.72	
Multiply for double turn by	2	
	295·44	$295.44 = 2s. 6d. per ton at 500 tons per week.

Total Number of Men Employed Hand Charging (Including Stokers).

	Per Two Furnaces.	Per One Furnace.
Per turn	12	6
Per double turn	24	12

WITH CHARGING MACHINE.

1 melter, wages per week	$30.00		
1 first helper (22½ cents per hour)	16.20		
2 yard loaders (12 cents per hour each)	14.40		
1 machine operator (20 cents per hour)	15.40		
1 boy	5.40		
6 Cost of labor in one week, single turn	81.40		
Multiply for double turn by	2		
	162.80	$162.80 = 1s. 3d. per ton at 550 tons per week.	
Net saving labor in one week		132.64	
		40	
Net saving labor in 40 weeks		5,305.60	
Less 10 per cent. depreciation and repairs	750.00		
Less 6 per cent. interest on cost of machine	450.00		
	1,200.00	1,200.00	
Net saving in 40 weeks		$4,105.60 = £844	

Total Number of Men Employed Machine Charging (Including Yard Loaders).

	Per Two Furnaces.	Per One Furnace
Per turn	6	3
Per double turn	12	6

Nothing is deducted for wear of cars and boxes, as it is not estimated that this will be any more than that on the barrows, tools, and cars used in handwork. Ten heats per week is assumed with hand charging and eleven with machine charging. The machine and its operator are charged to two small furnaces, whereas they could easily work six large ones.

Taking 40 working weeks only as a year, and allowing 16 per cent. on the cost of the machine for interest, depreciation, and repairs, the savings by each machine appear to be £844 per annum. This estimate takes no account of the gain in lower establishment charges by increased output. If we take the output of the two furnaces at 500 tons per week with hand charging, and 550 with machine charging, we shall find that by the former method the labor costs 2s. 6d. per ton of ingots, and by the latter only 1s. 3d. per ton.

The use of the machine, therefore, converts the advantage we have hitherto had in England over our American competitors in cost of labor to a similar advantage to them over us. In America lessened labor is generally synonymous with lessened cost for labor. It is not always so here.

Two Machines to Six Furnaces.—If the machine will charge one furnace in an hour, it is obvious that it will charge at least a dozen in the 15¾ hours which we have taken as the average duration of the heats (including charging and fettling) of a 40 ton furnace. But in practice this cannot be done, because the charges cannot be relied on to follow one another with precise regularity. One machine will, however, easily serve six furnaces. But bearing in mind the possibility of a breakdown, and the serious loss which might result therefrom, it is recommended that they should be used in pairs—that is, one to each six furnaces at work and one in reserve.* It will be noticed that the operator in the United States is paid at the rate of 45s. per week.

Supply of Materials.—The effectual employment of a charging machine is dependent on the materials being brought in charging boxes on specially constructed bogies to the charging platform, between the machine and the furnace front. The best arrangement provides for the full bogies arriving in succession at one end of the platform and the empties leaving at the other end. They are supposed to have been loaded at the stock heaps or input sidings, and to be returned straightway thereto. Charging platforms, where machine charging is in operation, are free from stocks of materials, standing wagons, and other impediments to a remarkable degree, and their coolness and cleanliness is at once remarked by those accustomed to hand charging.

Narrow Gage Bogie Line.—The charging bogies may reach the platform level by an incline fitted with a continuous creeper, which is an excellent device, and they may descend the same way, or be pushed up by a small locomotive, or be raised by lifts. Where, as in some British works, it is difficult to make these arrangements, the materials may continue, as previously, to arrive at the back of the platform, and be there loaded into the charging boxes on bogies. These, by aid of a few small turntables (such as are common on pit banks at collieries), can easily be pushed round by hand to a position where the charging bar can operate upon them. But the arrangement referred to above is best. The charging machine itself is frequently used as a locomotive to push away empties and bring forward full bogies.

Doors Lifted by Power.—In the United States the furnace doors are usually lifted by hydraulic or pneumatic power, operated by a boy in a pulpit at the back of the platform. One boy works the doors for two furnaces. This seems better than the plan of lifting them by levers attached to the furnaces, which is usual here.

Charging Castings and Cobbles.—For loading broken castings and heavy cobbles such as waste ingots, the machine may be used with great advantage. In that case the cobble would arrive on a charging bogie in the usual way, but the charging boxes would be dispensed with, and a broad fork having a socket shank would have been placed upon the bogie before the cobble was loaded up. The machine would lift the fork with the cobble on it, and introduce it into the furnace just as if it were ordinary material.

In case the weight of the casting or cobble were sufficient to overbalance the machine, the stability of the latter might be largely increased by depositing pig iron into the back box columns of the framework.

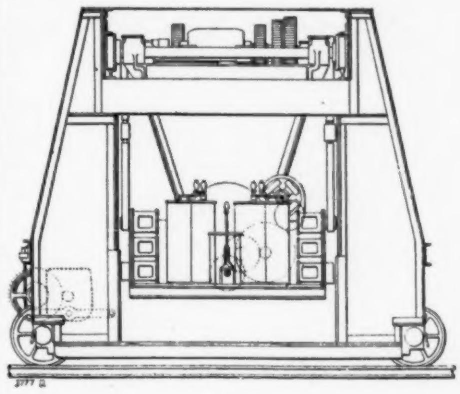


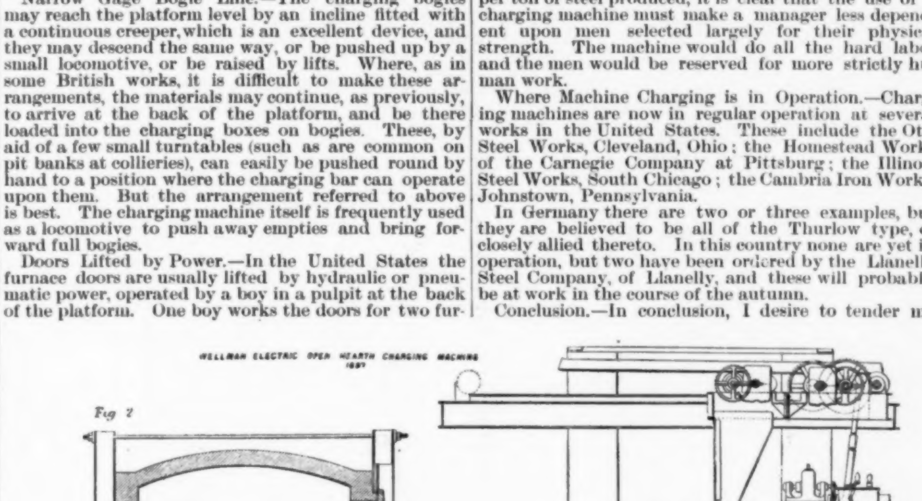
FIG. 4.

All Laborious Work Done by Machine.—Even if it were not found possible here to lessen the labor cost per ton of steel produced, it is clear that the use of a charging machine must make a manager less dependent upon men selected largely for their physical strength. The machine would do all the hard labor and the men would be reserved for more strictly human work.

Where Machine Charging is in Operation.—Charging machines are now in regular operation at several works in the United States. These include the Otis Steel Works, Cleveland, Ohio; the Homestead Works of the Carnegie Company at Pittsburg; the Illinois Steel Works, South Chicago; the Cambria Iron Works, Johnstown, Pennsylvania.

In Germany there are two or three examples, but they are believed to be all of the Thurlow type, or closely allied thereto. In this country none are yet in operation, but two have been ordered by the Llanelly Steel Company, of Llanelly, and these will probably be at work in the course of the autumn.

Conclusion.—In conclusion, I desire to tender my thanks to Mr. S. J. Wellman and his brother, Mr. C. S. Wellman, and their partner, Mr. Seaver, for much of the information I have been able to put before you; also to the Carnegie Company for allowing me to see the machines at their Homestead Works; also to Mr. G. Bartol, superintendent of the Otis Steel Works, and to my son and partner, Mr. A. P. Head, for preparing the illustrations, and otherwise affording me valuable assistance.



THE WELLMAN ELECTRIC OPEN HEARTH CHARGING MACHINE.

* There is no doubt that eight or more 40 ton furnaces might safely be worked with two machines.

MINERAL PRODUCTION OF THE UNITED STATES IN 1895–6.

Compiled for The Mineral Industry, Vol. V.,

By Richard P. Rothwell, editor of the *Engineering and Mining Journal.*

Number.	Products.	Customary Measures.	1895. Quantity. Customary Measures.	1895. Quantity. Metric Tons.	1895. Value at Place of Production. Totals.	1895. Value at Place of Production. Per M. Ton.	1896. Quantity. Customary Measures.	1896. Quantity. Metric Tons.	1896. Value at Place of Production. Totals.	1896. Value at Place of Production. Per M. Ton.
	Non-Metallic.									
	Abrasives:									
1	Carborundum	Sh. T.	113	102	$67,800	j$6.65	595	550	$365,612	j$6.65
2	Corundum	Sh. T.	385	349	53,900	154.44	250	227	35,000	153.75
3	Emery	Sh. T.	1,700	1,542	119,000	77.17	1,550	1,406	108,500	77.17
4	Garnet	Sh. T.	877	795	39,465	49.65	2,842	2,578	96,628	37.48
5	Grindstones	Sh. T.	36,380	33,004	290,378	8.79	31,301	28,396	294,338	10.36
6	Millstones	......	......	......	15,925	......	......	......	14,852	......
7	Tripoli & inf. earth	Sh. T.	1,788	1,617	26,040	16.00	2,425	2,190	31,928	14.56
8	Whetstones	......	......	......	93,303	......	......	......	105,201	......
9	Alum	Sh. T.	117,900	106,959	3,537,000	33.07	77,700	70,489	2,331,000	33.07
10	Antimony ore	Sh. T.	1,083	982	37,908	38.60	150	136	4,750	34.92
	Asbestos and talc:									
11	Asbestos	Sh. T.	664	602	11,887	19.66	716	650	12,670	19.49
12	Soapstone	Sh. T.	22,133	20,097	342,298	17.03	24,319	22,068	265,806	12.05
13	Talc, fibrous	Sh. T.	40,000	36,368	320,000	8.80	45,000	40,824	315,000	7.70
14	Asphalt	Sh. T.	25,525	23,156	170,500	7.36	20,500	19,926	66,900	3.36
15	Asphaltic limestone	Sh. T.	5,550	5,035	16,650	3.31	3,119	2,829	8,714	3.08
16	Bitumin's sandstone	Sh. T.	42,374	38,542	139,945	3.63	53,119	48,189	128,714	2.66
17	Barytes	Sh. T.	20,255	18,371	99,020	5.39	21,500	19,504	86,000	4.41
18	Bauxite	L. T.	18,800	19,100	56,400	2.90	17,006	17,369	68,384	3.93
19	Borax	Lbs.	13,506,356	6,126	742,850	j.12	15,258,014	6,921	762,900	j.11
20	Bromine	Lbs.	394,854	179	102,662	j.57	550,285	249	143,074	j.57
21	Cement, nat. hydraul.	Bbls a	7,694,053	1,047,006	4,597,285	4.39	7,454,611	1,014,423	4,353,877	4.29
22	Cement, Portland	Bbls b	749,059	135,879	1,430,080	10.52	1,032,654	187,365	1,710,151	9.12
23	Clay, refractory	Sh. T.	3,750,000	3,402,000	4,500,000	1.35	4,000,000	3,628,800	4,800,000	1.32
24	Clay, china	Sh. T.	30,910	28,035	258,431	9.22	29,418	26,688	217,551	8.15
25	Clay, common	Sh. T.	......	......	i60,100,000	......	......	......	i65,000,000	......
26	Coal, anthracite	Sh. T.	51,807,297	47,061,208	80,250,652	1.71	48,855,563	44,321,768	88,105,837	1.98
27	Coal, bituminous (h)	Sh. T.	137,328,600	124,584,506	123,807,958	1.00	138,463,254	125,613,864	115,827,813	.93
28	Coal, cannel	Sh. T.	69,747	63,274	191,804	3.03	54,600	49,587	146,486	2.95
29	Coke	Sh. T.	12,493,464	11,333,906	19,018,276	1.68	10,357,000	9,395,809	17,267,401	1.84
30	Cobalt oxide	Lbs.	6,400	j2,903	8,640	j.30	12,825	j5,817	16,672	j.28
31	Copperas	Sh. T.	14,118	12,806	69,846	5.45	11,170	10,133	52,662	5.19
32	Copper sulphate	Lbs.	45,000,000	20,412	1,750,000	85.73	48,732,840	21,605	1,949,313	90.22
33	Chrome ore	L. T.	1,553	1,578	16,795	10.64	702	713	7,775	10.90
34	Feldspar	L. T.	22,195	22,550	104,082	4.67	22,199	22,554	112,829	5.00
35	Fluorspar	Sh. T.	4,000	3,628	24,000	6.61	4,000	3,628	24,000	6.61
36	Gilsonite (k)	Sh. T.	1,150	1,043	34,500	32.12	1,700	1,542	54,500	35.34
37	Graphite, crystalline	Lbs.	377,450	172	17,286	j.50	405,006	184	18,225	9.90
38	Graphite, amorphous	Sh. T.	840	762	4,700	6.17	574	520	3,850	7.40
39	Gypsum	Sh. T.	298,572	270,864	974,219	3.59	231,640	210,152	739,799	3.52
40	Iron ore	L. T.	15,988,000	16,243,808	27,979,000	1.72	14,650,000	14,884,400	28,567,500	1.92
41	Lime	Bbls c	i60,000,000	5,443,164	30,000,000	......	i60,000,000	5,443,164	30,000,000	......
42	Magnesite	Sh. T.	2,200	1,996	14,700	7.39	2,067	1,875	13,435	7.16
43	Manganese ore	L. T.	170,509	173,237	328,107	1.84	162,526	165,126	339,098	2.05
44	Mica, ground	Lbs.	740,000	335	31,956	95.40	877,000	398	37,711	94.75
45	Mica, sheet	Lbs.	6,300	3	6,400	j2.13	8,000	4	8,405	j2.31
46	Mineral wool	Sh. T.	6,989	6,340	74,902	11.36	5,953	5,400	61,714	11.43
47	Monazite	Lbs.	1,900,000	862	114,000	132.40	17,500	8	875	100.37
48	Natural gas	......	......	......	12,000,000	......	......	......	10,000,000	......
49	Paints, mineral	Sh. T.	47,084	42,705	1,086,767	25.45	54,153	49,227	973,268	19.77
50	Paints, vermilion	Sh. T.	118	107	118,190	1105.00	96	87	94,677	1088.25
51	Paints, white lead	Sh. T.	92,980	84,314	8,768,656	104.00	95,068	86,246	7,802,267	90.46
52	Paints, zinc oxide	Sh. T.	22,600	20,498	1,588,300	77.48	16,799	15,240	1,259,925	82.67
53	Petroleum (crude)	Bbls d	52,961,943	7,215,896	47,024,913	6.60	61,396,394	8,364,631	56,963,137	6.81
54	Phosphate rock	L. T.	1,038,017	1,015,567	3,296,757	3.25	863,754	877,574	2,591,202	2.98
55	Marls	L. T.	217,700	221,188	587,790	2.67	155,000	157,480	418,500	2.65
56	Precious stones	......	......	......	250,000	......	......	......	200,000	......
57	Pyrites	L. T.	107,731	109,098	342,587	3.14	117,782	119,666	297,853	2.49
58	Salt, evaporated	Bbls e	12,091,265	1,535,501	5,643,383	3.61	11,156,270	1,416,846	4,828,179	3.41
59	Salt, rock	Bbls e	2,184,589	277,443	828,954	2.98	2,198,308	279,184	711,919	2.55
60	Silica, sand & quartz	L. T.	523,640	532,018	553,128	1.04	720,399	732,925	1,076,098	1.46
61	Slate, roofing	Sq'es.	752,606	238,576	2,494,213	10.45	699,100	221,615	2,260,862	10.25
62	Slate, manufactures	......	......	......	392,877	......	......	......	467,575	......
63	Soda, natural	Sh. T.	1,900	1,724	47,500	27.56	3,000	2,722	65,000	23.88
64	Soda, manufactured	M. T.	......	167,000	3,841,000	23.00	......	158,975	3,656,425	23.00
65	Stone, limestone (flux)	L. T.	4,723,154	4,798,724	1,889,262	......	4,311,563	4,380,548	1,724,625	......
66	Stone, marble	Cu. ft	......	......	2,898,114	......	......	......	2,600,429	......
67	Stone, onyx	Cu. ft	1,200	91	12,000	131.87	3,000	228	24,000	105.26
68	Stone, oölitic	Cu. ft	4,790,429	365,108	1,005,192	2.75	4,040,990	308,111	755,801	2.45
69	Other building stones	......	......	......	26,269,943	......	......	......	27,219,484	......
70	Sulphur	L. T.	1,650	1,676	41,250	24.00	2,800	2,845	64,200	22.56
71	Est. prod. unspecified	......	......	......	5,000,000	......	......	......	5,000,000	......
	Total non-metals	......	......	......	488,651,351	......	......	......	495,747,553	......
	Metals.									
72	Aluminum	Lbs.	900,000	408	495,000	j.25	1,300,000	590	520,000	j.18
73	Antimony	Sh. T.	466	422	70,332	166.42	613	556	85,700	154.32
74	Copper (m)	Lbs.	386,453,850	175,294	40,616,300	231.70	467,822,973	212,201	49,729,582	234.35
75	Gold	Ozs. f	2,265,612	j70,478	46,830,200	j664.60	2,837,965	j88,272	58,660,637	j664.60
76	Iron, pig	L. T.	9,446,308	9,597,449	108,632,542	10.77	8,623,127	8,761,120	91,577,610	10.45
77	Lead, value at N. Y.	Sh. T.	156,854	142,298	10,132,768	71.20	174,792	158,271	10,381,843	65.59
78	Platinum	Ozs. f	150	j.4.66	2,250	482.88	200	j.6.21	2,800	450.89
79	Quicksilver	Flks g	33,978	1,179	1,313,589	1114.00	33,180	1,151	1,227,660	1066.00
80	Silver, comm'l value	Ozs. f	46,331,235	j1,441,087	30,254,296	j20.99	56,222,322	j1,748,710	37,725,178	21.57
81	Zinc	Sh. T.	81,858	74,245	5,942,890	80.04	77,637	70,432	6,074,219	86.24
	Total metals	......	......	......	244,290,167	......	......	......	255,985,229	......
	Grand totals	......	......	......	......	......	......	......	......	......

(a) Barrels of 300 lbs.; (b) 400 lbs.; (c) 200 lbs.; (d) 42 gals.; (e) 280 lbs. (f) Troy ounces. (g) Flasks of 76½ lbs. (h) Bituminous coal includes brown coal and lignite. The anthracite production is the total for Pennsylvania, Arkansas, and Colorado. (i) Estimated. (j) Kilograms or per kilogram. (k) Including bitumen from Texas. (m) The value of the copper production is calculated at 0·25c. per lb. less than the average price of Lake copper at New York.

Abbreviations: Sh. T., short tons (2000 lbs.); L. T., long tons (2240 lbs.); M. T., metric tons (2204.6 lbs.); Sq'es, squares (100 sq. ft., lapped and laid).

From this table we find that the total value of the results of the mineral industry of the United States in 1896 reached the great sum of $751,732,782, which compares with a similar total of $732,941,518 for 1895. Of the total for 1896 we find that $495,747,553 was the value of the non-metallic products, while $255,985,229 was that of the metals. The former includes the sum of $5,000,000 for the value of various minor products unspecified.

It is necessary to make some deductions from these totals for products which are necessarily duplicated in the table, such as iron ore used in making pig iron; coal used in making coke; lead used in making white lead; copper used in making copper sulphate; limestone in making lime; salt for making soda; and a few other less important items of the same class. Making the deductions required for these, amounting to $45,717,371, we have as the total value of the production $706,015,411 in 1896, as compared with $682,065,118 in 1895; the change shown being an increase of $23,950,293, or 3·5 per cent. for last year.

In nearly every case the full returns now obtained and presented have established the closeness of our approximations made at the close of the year. In some cases the figures have hardly been changed; in others the differences between the estimated first returns and the corrected statements amount to only a very small percentage of the total.

We find from the table that while there were in 1896, as compared with the previous year, decreases in some important items, such as iron ore and pig iron, there were substantial gains in other important articles. In gold, for instance, there was a large increase, and in copper also the production was much larger. The coal output showed very little change, much less than might have been expected.

The United States in 1896 was the largest gold producer of the world and the largest silver producer; it was also by far the largest producer of copper, furnishing over one-half of the world's supply of that metal. Notwithstanding the decrease in the pig iron output it was still larger than that of any other country. In coal the total was still less than that of Great Britain, though it is gradually approaching the point where the two will be equal. In short, no other country in the world possesses a mineral industry of nearly as great value or variety. This is more remarkable also from the comparatively brief time in which the industry has been built up to its present proportions, and again draws attention to the energy and enterprise of our people, and to the ability of our mining engineers and metallurgists.

We give below brief summaries of the course of production during 1896:

METALS.

Aluminum.—The production of this metal remains in the hands of a single company, though recent patent decisions make it probable that the monopoly may be broken before long. The plant at Niagara Falls has made it possible to cheapen production and lower prices. An enlargement of the works has been required to meet the demand.

Antimony.—Production shows an increase, though the total is still small. The domestic production of antimony is derived partly from Californian and partly from imported ore.

Copper.—The production for 1896 reached the largest total ever reported, 467,822,923 pounds, equal to 208,850 long tons, or 212,201 metric tons. Over half of the production was sent abroad, the shipments to foreign countries amounting to no less than 125,605 long tons, or 59·2 per cent. of the output. Had it not been for an extraordinary foreign demand, the production of copper must have been very much curtailed, instead of showing as it did an increase of 81,369,123 pounds, or 21·1 per cent. The foreign demand also kept up the average price, which was 10·88 cents per pound for Lake copper in New York, against 10·76 cents in 1895. This price is probably about half a cent above the general average for the metal, when the large sales of electrolytic and casting copper are considered.

Gold.—Activity in the older mining regions of California and other States and the increased production of Cripple Creek and of some minor districts in Colorado, with improvements in several other States and in the Territory of Alaska, carried the gold production up to $58,660,727, showing an increase of $11,830,527 over 1895. The districts which attracted most attention during the year were Cripple Creek, in Colorado; the new Randsburg Mining District, in Southern California; the Mercur District, in Utah; the De la Mar Mines, in Nevada, and the mines of Alaska. In the latter there were many reports of new mines and a number of men went to the Yukon placers, but their success has been varied.

Iron.—The iron trade showed a reaction from the activity of 1895, and there was a decrease in the production of pig iron of 823,181 tons, or 8·8 per cent. There was a corresponding reduction in steel and finished iron in nearly all forms. The average price showed also a decrease. The year was one of extremely low prices in iron and steel; in fact, their range was regarded as the lowest possible until 1897 opened. The most notable fact of the year was the beginning of an export trade in iron and steel, which promises to reach large proportions.

Lead.—The production of lead in 1896 in the United States was 174,792 short tons (158,271 metric tons), an increase over 1895 of 17,938 short tons, or 11·4 per cent. This was made in spite of the closing of the Leadville mines in Colorado nearly half the year by the great strike.

Platinum.—The small production of platinum is chiefly from California, where the metal is obtained in parting and refining gold bullion at the San Francisco Mint.

Quicksilver.—The total production of quicksilver was 33,180 flasks, showing a small decrease—798 flasks—from that of 1895. The supply continues to come entirely from the California mines.

Silver.—The production of silver showed a large increase over the previous year, the total refined or obtained from our own ores having been 56,222,322 fine ounces, or 9,891,087 ounces more than in 1895. In addition to this product there was obtained by our smelters and refiners from foreign ores and bullion—chiefly from Mexico and British Columbia—33,053,555 ounces, making the total quantity of silver put into marketable form 89,275,877 ounces.

Zinc.—The output of metallic zinc or spelter in 1896 was 77,637 short tons or 70,432 metric tons, and was less than that of 1895 by 4,221 short tons, or 5 per cent. This decrease was divided among the different producing districts, and was the result chiefly of limited demand for the metal. Our producers are able to increase the supply largely, if a market can be found for it. New uses for the metal, especially for roofing, have been suggested and ought to be furnished.

NON-METALLIC PRODUCTS.

Abrasives.—Under this head are included a number of substances, most of which show comparatively small changes. Carborundum shows an increase; its use is extending in different quarters as the material becomes better known, and the manufacturers of this artificial abrasive are arranging to extend their output. Corundum comes chiefly from North Carolina and Georgia and shows a small decrease. The output of emery increased slightly, but we are still largely dependent upon imported supplies of this article. The supply of tripoli and infusorial earth continues to come mainly from the Missouri deposits, those in Florida being still undeveloped. In grindstones, millstones and whetstones there were no important changes. The demand for millstones has been largely reduced in recent years by the use of improved processes for making flour from grain.

Alum.—There was a decrease of 40,200 short tons, or 34 per cent. in the production, the result of a lessened demand from the manufacturers who use this article.

Asbestos and Talc.—There was little change in the production of asbestos, and we continue to import a considerable quantity from Canada. The output of fibrous talc showed little change also, no new producers having come into the market. The lower grades of talc and the soapstone show also no material difference.

Asphaltum and Bituminous Rock.—A change has been made in our table this year, asphalt, asphaltic limestone, bituminous rock and bituminous sandstone being reported separately as being products of distinct grade and different uses, whereas in most returns they are given together under a single head. The production, upon the whole, shows little change; that of asphalt decreased, as did asphaltic limestone, but there was an increase in bituminous sandstone.

Barytes.—No material change is noted in this product, an increase of 1,245 short tons only being shown.

Bauxite.—The production of bauxite, 17,006 short tons, which was entirely from the Georgia mines, shows a decrease.

Borax.—There was an increase of 1,751,658 pounds in the production. The greater part now comes from the mines in Southern California, the Nevada marshes being worked only to a limited extent. The business is still in the hands of a single producer, the Pacific Coast Borax Company, which in 1896 consolidated with the Redwood Chemical Works, of Great Britain. The consolidated company practically controls the borax output of the world.

Bromine.—An increase of 155,431 pounds, or nearly 40 per cent., is reported in this product, the total amount still being limited by the demand, which increases slowly.

Cement.—The cement producers reported in 1896 a decrease of 139,442 barrels in the production of natural hydraulic cement. This was more than made up, however, by an increase of 283,595 barrels in Portland cement. This would indicate a production slightly increased in 1896, and a growing demand for the manufactured or Portland cement.

Clays.—The clay industries are of a very considerable importance in the aggregate, but are very largely in the hands of small producers or manufacturers, scattered all over the country, thus making the collection of statistics a difficult matter. We find in 1896 a gain in the production of refractory clays and firebrick. In china clay or kaolin there was a small decrease only.

Coal and Coke.—The total coal production in 1896, with a possible modification in the Ohio figures, was 187,373,477 short tons, showing a decrease of 1,922,167 tons, or 1 per cent., as compared with 1895. The decline was wholly in anthracite, the output of which de-

creased 3,041,734 tons, or about 6 per cent. In bituminous coal there was less change than might have been expected in a year of business depression and lessened industrial activity, a gain of 1,134,654 tons being noted. There was a drop in values exceeding the change in production, owing to the very low average price realized. Coal sold at the mines in many parts of the United States at lower prices in 1896 than had ever before been accepted. Heavy production and sharp competition in a year of comparatively light demand were responsible for this result. Unfortunately, there appears to be little prospect for relief for the coal operators. In such a condition the districts which produce at the lowest cost and are best situated in relation to the markets will certainly secure the trade and others must suffer.

Coke showed a total production of 10,357,000 short tons, a decrease of 2,136,464 tons, or 17·1 per cent., from 1895. The coke trade is so dependent on the demand from the iron furnaces that its changes follow very closely those in iron production. The only matter worthy of note is the beginning of a movement which may in time transfer the chief center of coke production from Western Pennsylvania to West Virginia. Some progress was made in 1896 in the introduction of by-product coke ovens.

Cobalt Oxide.—The production in 1896 was about double that of the preceding year.

Copperas.—The production shows a slight decrease, as was to have been expected ; the difference amounted to about 3,000 short tons.

Copper Sulphate.—The production was about the same in 1896 as in the preceding year. The exports of this material are considerable and the demand is well maintained.

Chrome Ore.—The output, which comes entirely from the California mines, was only about one-fourth of that reported in 1895. Our principal supplies of chrome ore for Eastern manufacturers continue to come from abroad.

Feldspar.—There was very little change in the production of this mineral.

Fluorspar.—The estimated output of 4,000 tons of the Argyle Fluorspar Company for 1896 is about the same as that of the preceding year.

Gilsonite.—The production from the Utah mines was 2,650 tons, showing a large comparative increase, though the total is still small. The question of opening to location the gilsonite deposits on the Uncompahgre Indian reservation in Utah is still unsettled.

Graphite.—An increase of 27,556 pounds is reported in this mineral. There was a decrease in the small production of amorphous graphite, which is used for foundry facings.

Iron Ore.—The decrease of 1,338,000 tons corresponded nearly to that in pig iron production. The stocks of ore on hand at the opening of the year were generally light.

Lime.—The production showed comparatively little difference from that of the preceding year.

Magnesite.—But little change is shown in the output of this mineral, which continues to come almost entirely from the California mines. Most of the product is also used on the Pacific Coast. The total in 1896 was 2,067 short tons.

Manganese Ore.—The total production in 1896, including manganiferous iron ores, amounted to 162,526 long tons, and was 7,983 tons less than in 1895. A large quantity of manganese ore is still imported.

Mica.—The production in 1896 included 8,000 pounds of sheet mica and 877,000 pounds of ground mica. This comes chiefly from the North Carolina and New Hampshire mines. The production does not yet equal the demand, which is increasing, especially for electrical work.

Mineral Wool.—The production last year was 5,953 tons, showing a decrease of 15 per cent.

Monazite.—The output fell from 1,900,000 pounds in 1895 to 17,500 in 1896, the North Carolina product being unable to withstand the competition of the Brazilian.

Natural Gas.—There was a decrease in the value of this product, owing to the partial exhaustion of the supplies in certain districts.

Paints.—In mineral paints, chiefly the iron oxide paints, there was a considerable increase, the total in 1896 being 54,153 short tons. Of vermilion only 90 tons were reported. The production of white lead was large, reaching 95,068 tons in 1896, or 2,129 tons more than in 1895. Zinc white, on the other hand, decreased in production, the total of 16,799 tons reported being less than that for 1895 by 5,891 tons. It may be noted that most of the zinc white is made directly from the ores, and not from metal like white lead.

Petroleum.—The production of crude petroleum was 61,396,394 barrels, or more than that of 1895 by 8,434,451 barrels. No new fields of importance were discovered during the year, but there was considerable extension of work in the West Virginia field. The value of the new oil field in Tennessee is not yet determined.

Phosphates and Marls.—A heavy decrease in the production of phosphate rock is shown, due to the closing down of many of the South Carolina and Florida producers on account of low prices and light demand for export. The new phosphate fields in Tennessee promise well, but their production has not yet reached an important amount. The total output of phosphate rock in 1896 was 863,754 tons; of marl, 155,000 tons.

Precious Stones.—A value of $200,000 is given to our production, which varies but little from year to year.

Pyrites.—The total production, chiefly from the mines of Virginia and Massachusetts, was 117,782 long tons, an increase of 10,051 tons. This was, perhaps, less than might have been expected in view of the high price of sulphur, which would naturally lead to an increased use of pyrites in acid making.

Salt.—The total output in 1896 was 13,354,573 barrels (of 280 pounds); 11,156,270 barrels being salt obtained from brine by evaporation, and 2,198,303 barrels rock salt. There was a slight decrease from 1895.

Silica, Sand and Quartz.—The production of 720,399 long tons was larger than in the preceding year.

Slate.—The total value of slate, roofing and manufactured, was $2,728,437, a small decrease from the preceding year, but less than was anticipated in a year when building was not active.

Soda.—The production of manufactured soda in 1896 was 158,975 metric tons, or 8,025 tons less than in 1895. This was due entirely to the depression of business and consequent decreased demand. The production of natural soda from California—3,000 tons—continues small.

Stone.—Under this head there are included several classes of products, all of which showed a decreased output. This was naturally the case in a dull year when new building enterprises were limited in their extent. The stone industry is one of those in which it is very difficult to obtain correct statistics, owing to the great number of small quarries in all parts of the country, which are worked irregularly to supply local demands. The value of the products of such quarries is considerable in the aggregate. Onyx, a stone used entirely for ornamental purposes, showed an increase, 3,000 cubic feet having been quarried. Limestone used for flux in iron making showed a decrease.

Sulphur.—A small production—2,800 tons—is reported from Utah and Louisiana. The mines in the latter State were worked only to a very small extent and irregularly. The higher price of Sicilian sulphur should aid to develop the industry, and arrangements are in progress to work the Texas deposits, which are believed to be of considerable extent and value.

Other Products.—Although our list has been extended year by year, as noted above, and has been made with great care, there remain a number of minor products which it is difficult or impossible to classify. The value of those is in most cases small, but their total reaches a considerable sum; and we believe that the $5,000,000 allowed to cover it is really a very conservative estimate.

COFFEE GROWING IN INDIA.

By F. A. SYMONS.

OF all the products of the vast empire of India, perhaps there is nothing that pertains more closely to the comfort of the individual than coffee. As we sit at our breakfasts, inhaling the fragrant odor and imbibing the stimulating decoction of the coffee bean, how many of us can trace it from its present form, backward to its source, much farther than the nearest grocer's shop ?

Through the southern portion of India runs a range of mountains, easily found on any map, called the Ghauts. Along the eastern slopes of this range of hills and the undulating valleys between the hills are the homes of the coffee and its planters. The Ghauts being a very extensive range, run through several provinces, of which Mysore, Coorg, and the Wynard district stand out pre-eminently. The Mysore portion runs, of course, through the native state of that name, while Coorg is under British government. The Wynard district is the oldest coffee and also tea growing land in this part of the world, having been started in 1830. It comprises a portion of the Nilgherry Hills, of world wide repute, and here is the famous Ouchterlony Valley, first planted in 1840. Travancore and Cochin are two other small native states, growing a little coffee, but are of not so much importance, but the bamboo district of Coorg is excellent.

In picking out a situation for starting a plantation, the undulating valleys between the hills and the slopes of the same are found to afford the best conditions. The best soil is generally a dark, rich loam of a chocolate color, and one of the most prolific earths is caused by the accumulations of detritus, etc., washed down the hill. A damp subsoil is very unfavorable, and a naturally drained locality is, therefore, most sought after.

In the best parts of the Mysore district the greatest amount of rain falls during the period of the southwest monsoon, from the middle or end of May until October, and the most profitable years are those during which the rainfall for the whole year is from sixty to eighty inches. With such a yearly rainfall, fifty to fifty-five inches generally falls during the period of the monsoon (May till October). The average temperature during the monsoon months ranges from 68° to 76° F., while it rises to a general average of 90° in March and April. The average elevation of the best estates is almost three thousand feet, the bamboo district of Coorg being somewhat under this, two thousand five hundred, and some parts of Mysore and the Nilgherrys, four thousand and five thousand feet respectively.

The size of a plantation usually runs from one hundred to two hundred and fifty acres, the commonest size being about one hundred and fifty. During his first year, the planter will clear and plant from fifty to seventy acres, if he is lucky in succeeding in hiring a sufficient number of coolies to do the work. Having carefully selected the trees which will be suitable for shading purposes, the undergrowth of scrubs and prickles is cleared away and burnt, and the useless trees cut down. The natural jungle trees are not suitable, as a rule, for shade, as they are apt to shed their leaves in the hot weather (when these are wanted most), and a great many of them are surface feeders, and thus injure the delicate coffee plants. At this stage, which is usually about October or November, a nursery of small plants is prepared, so as to have something to plant when the ground is clear and ready. This nursery, which is usually placed in the near neighborhood of water, is made by planting coffee seeds about three inches from each other (in every direction). These are then left to grow, while the more extensive operations are proceeded with.

Rows of pegs are driven into the ground in parallel lines, five feet from each other, the same distance being left between each row. This process is called "lining," and as it is carried out, a row of coolies follow, who dig a hole wherever they find a peg. These holes are made in the form of an eighteen inch cube and are filled with surface vegetable mould, the dug-up earth being spread on the surrounding level.

At the end of May, when the southwest monsoon bursts, bringing the yearly supply of water, the young plants in the nursery are a foot in height and ready for planting in the cubical holes. Each little plant is dug up with a ball of earth from the nursery beds left adhering, in order that it may have no check in its growth should the rain cease for a time, as it often does. One acre will provide accommodation in this way for 1,742 trees. Shade at this time of year is of very little importance, on account of the continuous rain, and the opportunity is now taken to plant the shade trees for the coming hot mouths. Few of the natural trees having been found suitable to remain, the new young trees are planted, so as to leave three rows of coffee plants between every two rows of shade trees, in every direction. The best trees for the purpose belong to the fig and cedar tribe, prominent among which are the Ficus mysorensis and the Ficus glomerata.

This brings us to the end of September, and from now until November various coolies are employed to weed and clean up the young plantation, which is then left to grow by itself until the following June, when the monsoon rain again comes on. By the time June arrives, the plants are about two feet in height, having four to six pairs of primary branches, and the shade trees are about a foot higher. The planter now inspects his stock and replaces any plants that may have gone wrong with fresh ones from the nursery. No crop is gathered until the third year, when the plants are three feet in height. This third year crop is called the primary crop, but only half of it is gathered, the remainder being plucked in the budding state in order to increase the strength of the growing plants. The shade trees are now eight feet in height, and the ground having run by itself for three years, it now becomes necessary to feed it with nitrogenous manure, and to supply aeration for the roots. This latter effect is produced by digging square holes, about eighteen inches deep, between every four trees. These holes also act as passages for drainage.

Three years have passed since the first investment of his capital, and the patient planter looks forward to reaping something in return, nothing having as yet been gained, except the half of the small primary crop, worth as a rule about 20 rupees ($5.50) an acre. He now anxiously looks for the showers of April, as upon the severity of these depends in a great measure the final success of his labors. Supposing a good shower fulfills his expectations, the outer covering of the buds opens gradually until the morning of the eighth day, when suddenly there bursts forth the pure white blossoms of the coffee, covering the plantations like a fall of snow, and showing up against the green leaves in beautiful contrast. If, however, the longed for shower is of very small quantity and not followed by another in a few days, the buds open slightly, but never come to flower, being burnt up in the sun, while the heart of the owner grows sad within him. A good plantation, with luck, ought to produce a yield in the fourth year of 3 cwt. of beans per acre, worth about 68 or 70 rupees ($20) a cwt. To this is added the primary crop of the year before, bringing up the total yield to about $75 an acre, and the land has cost for labor, etc., about 250 to 300 rupees ($75 to $90) an acre. The expenses for first three years are thus very nearly recovered after the first full crop, but the waiting is somewhat lengthy and anxious, as can be understood from the above description. The fifth year ought to bring in 4 cwt. an acre, and this will be about the full limit.

The ripe coffee fruit is about the size and appearance of a cherry, being slightly elongated, and like the cherry it has an external pulp, which greatly attracts mischievous birds and monkeys. Inside the pulp, with their flat surfaces opposite each other, lie the two seeds. These berries, having been all carefully picked by women and children (a smart woman earning 4 annas—about 8 cents—per diem), are passed through a machine somewhat like a chaff cutter and called a "pulper." This process throws out the seeds into vats, while the pulp is rubbed off and cast out behind, the power being supplied by hand or bullocks as a rule. The vats are made of masonry with tiled floors, and may be any size from 6 × 6 ft. to 10 × 10 ft. The seeds are now piled up in a corner of a vat and allowed to ferment all night, and sometimes during the whole of the following day, so as to act upon the thick, gummy material covering them after the pulp is gone. When the fermentation has sufficiently worked up the gummy coat, the heaps of seeds are spread out on the floors of the vats and the gum removed by the tramping of coolies' feet. Water is now let into the vats, and long rakes stir up the contents. Having sufficiently separated the beans from their surroundings, the water is drained off, and the coffee spread on tables, covered with fine wire netting or cocoanut matting. This netting allows of the perfect drainage of the water, and the sun completes the drying, which is effected by leaving the beans for one to two days on mats on the ground, until they become of the consistency of bone. Being still covered with a thick parchmentlike coat, it is now put into bags and sent to the coast, where the curing agents separate the parchment in their factories, and transmit the thus produced coffee of commerce to the planter's agents in London, where it is sold by auction at Mincing Lane to the wholesale merchants.

Another duty of the curing agents is to divide the beans into three classes, according to their size—A, B, and C—the largest being A. Besides these three varieties of the ordinary bean, there is a class composed of malformed berries, called "pea berries," which are elongated and roundish, without any flat surface. This latter bean is considered much more valuable than the A, B, C classes, on account of being easier to roast, and because it is supposed to contain more strength and pabulum—only one bean being found in each succulent berry instead of two. When ordinary coffee is selling in Mincing Lane for 100 shillings a cwt., the pea berries fetch from 115 to 125 shillings. By the middle of January all the ripe fruit has been picked by the coolie women and children, and there remain only the stunted, unripe berries of poor quality. These, which will not ripen readily, are stripped off green and dried in the sun, the hard coverings being pounded off on the estate, as they are not worth sending to the curers. To this latter class are added the gleanings from the ground (the monkeys and birds having knocked off a good many berries during their depredations), and the whole together is sold to the small native dealers, who further sell on the coast to Arabs from the Persian Gulf. The Arabs convey these leavings to Mocha, from whence it is shipped as pure Mocha coffee.

A great quantity of this variety is also shipped to Marseilles, as France is found to afford a ready market.

The planter therefore produces his coffee, pays the fees of the curing agent at the coast, the freight to England, and duty and brokerage in London, receiving in return the price obtained in Mincing Lane.

A fair calculation for a first class estate, worked on the lines described, would be as follows : Complete cost of producing, and of landing in London, $30 to $35 per acre; yield per acre, 3 to 4 cwt.; price at Mincing Lane,

$22 to $25 per cwt.; profit, $40 to $50 an acre per annum.

It would be interesting to compare these labors and their results with those of the fruit grower in America, especially to the planter, who is always eager to read the details of occupations resembling his own.

RAISING GOLDFISH.

GOLDFISH are so extremely common nowadays that few people ever stop to wonder where they come from or how they are raised, says the Chicago Tribune. Comparatively little is generally known about the little cold-blooded vertebrates that swim about in the aquariums in so many homes. The pets require a careful and systematic raising that is scarcely appreciated by those who expect to get them for small prices of dealers in the city.

The largest goldfish farm in the world, if it may be called such, is located in Shelby County, Ind., about thirty miles from Indianapolis. Here the original goldfish men of the country have their propagating institution.

There are two farms, several miles apart, which are devoted to the different branches of the industry. In the north part of the county is one farm of eight or ten acres. The other is a few miles further south, and is about half again as large as the first one.

To-day there are in the various ponds of Spring Lake fishery over 200,000 fish, from which specimens are constantly being sent to every State and Territory of the Union. It is even said that some of the finest fish in the royal aquariums of Europe were raised by Mr. Shoup and his partner at this farm.

On each of the farms spoken of are a large number of small ponds, some of them not much larger than ten feet square. These ponds are all connected with each other by little channels, so that the water and fish can be let from one to the other without the least difficulty.

The breeding ponds, which are, of course, the most important, are protected from the wind and cold by high embankments around the edges. This is all the protection that is necessary for the fish, even in the winter time. So it is seen that, although the fish are undoubtedly delicate, they are much more hardy than is generally supposed.

Several times a year the fish are sorted in the different ponds and classified, so that the largest and finest ones will be together, and those which will not bring such good prices will be by themselves. Many people suppose that when the goldfish is first hatched from the egg it has the peculiar pretty markings on its scales which make it so beautiful and valuable.

This is not the case. In its youth in reality the fish is just the same as any ordinary and everyday fish, and looks like it for all the world. Even an expert could scarcely tell it from the little minnows which are found in any stream. They are of a whitish silvery color, and have not the least evidence of the beautiful hues which they will later assume.

Sometimes, however, the goldfish grower is sadly disappointed in finding that his fish fail to acquire the golden tint for which he has so long been looking in vain. There have been many instances time and again in which the fish never did change to the reddish color, but grew to be several years old, retaining their white, silvery, youthful complexion. Ordinarily, however, the fish develop the golden shade in less than a year.

First they begin getting dark, sometimes becoming almost black. From the dark complexion they begin turning to the reddish shade and finally come out in all their glory, full-fledged goldfish. Often the fish, instead of acquiring a solid color all over its scales from nose to tail, becomes spotted with big red blotches here and there at regular intervals over its body.

The food has not, as many people suppose, the least thing to do with coloring the fish. All the fish are fed exactly the same thing—toasted bread two or three times a week, and nothing else, is given them for their subsistence. The sun seems to be the necessary agent and the only one to complete the scheme of nature, and even this sometimes does not work successfully.

The greatest difficulty with which the goldfish raiser has to contend is the pest world. Snakes, cats, coons, frogs, and insects innumerable are all fell destroyers of the goldfish, and the crawfish is by no means a second in the destruction which he can work when he gets in the neighborhood of the finny tribe. Some one must be kept constantly on watch at the season of the year when these insects and little animals abound, to see that they do not get into the water of the pond where the fish are.

The sting of some insects will kill a fish in almost every instance. Snakefeeders and some other well-known insects fly close to the surface of the water in the summer time, and with the greatest ease touch the tiny little fish swimming near the surface of the pool. An egg is laid on the fish or a stinger inserted, and either one will invariably prove fatal.

The freaks and unusual developments in the fish are the varieties which will always bring the best prices in the market. Odd and rare colors and spots upon the scales are the marks which are preferred by fanciers. Unusual shapes in the fishes are equally popular with oddities in colors, and will cause a fish to bring as good a price as if it had orange or purple scales.

In physical developments the greatest varieties are in respect to the tail. One never finds two-headed fish, but those with more than one tail are plentiful. Two, three, four and five tails are quite often found on the fish, and sometimes even six, but the latter is very rare. Of course, a fish with six tails would bring a handsome price in any market.

Goldfish are often killed by over-attention, but sometimes by lack of attention. The two things which above all should be avoided are overfeeding them and failure to keep fresh water in the aquarium. An even, moderate temperature should be maintained, and they should be kept in the dark at night.

The bill for providing funds for building the New York Public Library has been signed and the call for the preliminary sketches of the architects has been made. It is expected that, architecturally, the result will be as creditable in New York as the Boston Public Library in Boston, or the new Library of Congress at the national capital.

Recent Books.

Alloys. The Metallic Alloys. A Practical Guide for the Manufacture of all kinds of Alloys, Amalgams and Solders used by Metal Workers; together with their Chemical and Physical Properties, and their application in the Arts and the Industries; with an Appendix on the Coloring of Alloys and the Recovery of Waste Metals. Edited by W. T. Brannt. Illustrated by 34 engravings. A new, revised and enlarged edition. 8vo, cloth. 527 pages. Philadelphia, 1896 .... $4 50

Alternating Currents. Theory and Calculation of Alternating Current Phenomena. By Charles P. Steinmetz, with the assistance of Ernst J. Berg. 8vo, cloth. 431 pages. Illustrated. New York, 1897.......... $2 50

Batteries. How to Make and Use the Storage Battery, embracing its History, Theory, Maintenance and the Installation of Plants. By B. P. Warwick. Illustrated. 12mo, cloth. 140 pages. 1896.......... $1 50

Bearings and Lubrication. A Handbook for every user of Machinery. By A. J. Wallis-Tayler. 12mo, cloth. 208 pages, 75 illustrations. London, 1896.......... $1 50

Bicycles and Tricycles. An Elementary Treatise on their Design and Construction, with Examples and Tables. By Archibald Sharp. With numerous illustrations. 536 pages. London, 1896.......... $4 00

Bicycles. Modern Cycles. A Practical Handbook on their Construction and Repair. By A. J. Wallis-Tayler. With over 300 illustrations, 340 pages. 12mo, cloth. London, 1897.......... $4 25

Cast Iron. Metallurgy of Cast Iron. A complete Exposition of the Processes involved in its Treatment, Chemically and Physically, from the Blast Furnace through the Foundry to the Testing Machine. By Thomas D. West. Fully illustrated. First edition. 12mo, cloth. 573 pages. Cleveland, 1897.......... $3 00

Cement. Hydraulic Cement. Its Properties, Testing and Use. By Frederick P. Spalding. 12mo, cloth. 265 pages. Illustrated. New York, 1897.......... $2 00

Climatology. A Handbook of Medical Climatology, embodying its principles and therapeutic application, with scientific data on the chief Health Resorts of the world. By S. E. Solly. Illustrated in black and colors. 8vo, cloth. 470 pages. Philadelphia, 1897.......... $3 50

Coachbuilding. The Art and Craft of Coachbuilding. By John Philipson. (Technological Handbooks.) 12mo, cloth. 191 pages, fully illustrated. London, 1897.......... $1 75

Compressed Air. Practical Information upon Air Compression and the Transmission and Application of Compressed Air. By Frank Richards. 12mo, cloth. 203 pages Illustrated. New York.......... $1 50

Dairy. The Book of the Dairy. A Manual of the Science and Practice of Dairy Work. Translated from the German of W. Fleischmann. By C. M. Aikman and R. Patrick Wright. 8vo, cloth. 344 pages, illustrated. London, 1897.......... $4 00

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